Vol. 86 MAY-JUNE 1959 No. 3

Bulletin

of the

Torrey Botanical Club

JUL 24 1959

CONTENTS

The Halimeda and Caulerpa of Onotoa, Gilbert Islands. *Edwin T. Moul* 159

Fruiting Grimmia Hartmanii var. Anomala in America. *Elva Lawton* 166

Geographical Distribution of Characeae. *E. D. Wood and K. Imahori* 170

The Chlorophyll Content of Tea. ..... *Frederick T. Wolf* 184

Alfaroa and Engelhardtia in the New World ..... *Wayne E. Manning* 190

Torreya

Note on Radial Tree Growth. By Carl D. Monk. Supplementary Notes on Cynanchum, Elscholtzia and Other Local Plants. By Joseph Monachino. Proceedings of the Club. Book Review. 199

Index to American Botanical Literature. 208

Published for the Club bi-monthly

by

THE BUSINESS PRESS, INC.
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PENNSYLVANIA

THE TORREY BOTANICAL CLUB

Officers for 1959

President: GEORGE L. MCNEW

Vice-president: WILLIAM C. STEERE

Recording Secretary: REGINA M. DUFFY

Corresponding Secretary: ANNETTE HERVEY

Treasurer: RITA M. MCMAHON

Editor: CHARLES A. BERGER

Manager for Publications: JACK MCCORMICK

Bibliographer: MRS. LAZELLA SCHWARTEN

The Bulletin of the Torrey Botanical Club

Editor

Charles A. Berger

Associate Editors

Irving W. Bailey
Stanley A. Cain
Adrianne S. Foster
Barbara McClintock
Murray F. Buell (Memoirs)
Edwin B. Matzke
Wendell H. Camp
Donald P. Rogers
H. W. Rickett
Frederick Kavanagh
John A. Small (Torreya)

Membership dues should be sent to Dr. Rita M. McMahon, Fordham Univ., New York 58, N. Y. Subscriptions and correspondence about advertisements and back numbers should be addressed to Dr. Jack McCormick, Amer. Museum of Nat. History, New York 24, N. Y. Manuscripts intended for the Bulletin should be sent to Dr. C. A. Berger, Biological Laboratory, Fordham University, New York 58, N. Y. Material for Torreya should be sent to Dr. John A. Small, Douglass College, New Brunswick, N. J.

Claims for missing numbers must be made within 60 days from the date of issue. Changes of address of members should be sent to the treasurer.

The subscription price of the Bulletin of the Torrey Botanical Club (including Torreya), is $9.00 a year except to active members of the Club. The annual membership dues covers a year's subscription to the Bulletin.

Entered as second-class matter October 8, 1940 at the post office at Lancaster, Pa., under the Act of March 3, 1879. Accepted for mailing at the special rate of postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 86, NO. 3, PP. 159–165 MAY, 1959

THE HALIMEDA AND CAULERPA OF ONOTOA, GILBERT ISLANDS

EDWIN T. MOUL

Published records of algae from the Gilbert Islands in the southwest Pacific are rare. Setchell (1928) visited Onotoa and wrote a brief description of the algal ridge surrounding the atoll. Moul (1957) has made a preliminary report of the flora of Onotoa including the algae. This paper is a record of the Halimeda and Caulerpa species collected at Onotoa, Gilbert Islands, by the 1951 Expedition of the Pacific Science Board, sponsored by the Office of Naval Research.

Onotoa is the southernmost atoll in the Gilberts; two reef islands are farther south. It is south of the equator and west of the International Date Line, at 1° 47′ 33″ S. and 175° 29′ 30″ E. It is typical of most atolls of the Gilbert group, a ring-shaped outer reef and a central lagoon, with almost continuous land only on the windward side. The longest distance from reef edge to reef edge is from north to south and is approximately 12 miles. There are 5.2 square miles of land and 21 square miles in the lagoon. Cloud (1952) has described the geology and marine environment in detail.

The lagoon is divided into three shallow basins with a maximum depth of 15 meters. The southern basin is the largest and deepest. These basins are separated from each other and from the sea by numerous patch reefs and sand flats that rise to near the surface at low tide. Navigation in the lagoon requires care and knowledge, because of the many scattered coral knolls, particularly along the leeward reef. Strong surf occurs on the windward reef to the east and south and this reef is partly dry at low tide. The surf is weaker on the western exposure and at the north end of the atoll. Large areas in the northern end of the lagoon are dry at low tide. The floor of the lagoon is composed of lime sand and gravel. All passes in the reef for crafts of shallow draft are on the leeward side. The best anchorage is outside the northernmost pass.

The algae described were collected by the author and by Dr. Preston E. Cloud, Jr., Dr. A. H. Banner and other members of the expedition in the course of their own survey work. Specimens have been deposited at the following Herbaria: U. S. N. Herbarium, Bernice P. Bishop Museum, University of Michigan, Chrysler Herbarium at Rutgers University, Alan Hancock Foundation at Los Angeles, New York Botanic Garden, Universidade de Sao Paulo, Brazil, Farlow Herbarium at Harvard University, and University of California at Berkeley.

[THE BULLETIN for March–April 1959 (86: pp. 81–157) was issued June 23, 1959.]

HALIMEDA

Six species of Halimeda have been identified. Four of these are species first described by Taylor (1950) from Bikini. Because of the superficial resemblance of the different species in their external morphology, identification was made by examination of the nodal structure and tissue of decalcified material prepared as suggested by Taylor (1950). Existing papers on the genus by Barton (1901), Yamada (1941), Gilbert (1947) and Taylor (1950) were used for nomenclature.

KEY TO HALIMEDA SPECIES OF ONOTOA

1. Plants branching in various directions and attached at several points ..... *opuntia.*
1. Plants branching in one plane and with a single point of attachment ..... 2.
2. Segments at base fused into a single stalk consisting of two or more segments, upper segments trilobed ..... *incrassata.*
2. Segments not fused at base into a single stalk, upper segments rarely trilobed ..... 3.
3. Large rhizoidal stipe from which several branches arise; nodal filaments in a common group with a few pores between filaments ..... *stuposa.*
3. Large stipe absent; nodal filaments free and single or 2 or 3 fused ..... 4.
4. Subcortical filaments enlarged and swollen; peripheral utricles angular, forming a continuous membrane after decalcification; heavily calcified and nitent ..... *taenicola.*
4. Subcortical filaments not enlarged; peripheral utricles round in surface view and free after decalcification ..... 5.
5. Medullary filaments fused in pairs at the nodes; upper segments reniform and from 2 to 3 cm. in width ..... *bikinensis.*
5. Medullary filaments free at the nodes; upper segments smaller ..... *fragilis.*

Halimedas were not common as a vast turf or meadow as reported from the West Indies and Florida. They existed as patches in grooves and pocket-like depressions of the leeward and northern reefs of the atoll or as scattered patches on the top and sides of coral knolls in the western part of the lagoon. However, the bases of some coral knolls were surrounded by small circular patches of Halimeda. This was the only time I saw a comparatively pure turf-like stand of any size. The segments of the plants were present in the bottom deposits of the lagoon. One species, *Halimeda stuposa*, was confined to the shallow sandy flats at the northern end of the lagoon. Only one species of Halimeda was collected on the windward reef (eastern reef), but lack of material from this situation may be due to the inability of the team to cover this chaotic environment or the fact that the group as a whole grow in quiet and more sheltered situations. The one specimen mentioned above was adrift in a tide pool.

HALIMEDA OPUNTIA (L.) LAMOUROUX. The most common and widely occurring species of Halimeda on the atoll. Most of the material was collected on the western reef or on coral knolls along the western side of the lagoon.

Only one collection was made on the windward reef and this specimen had apparently been washed into a tide pool. Microdictyon was growing on it as an epiphyte.

This species was never in great abundance, but was generally growing in small patches or in a circle, turf-like around the bases of coral knolls, from just below the surface to a depth of 6 meters. The plants were generally low and vinelike, with rhizoidal attachments at several points. There was no distinct central stem, and the branching was irregular, not in a single plane. Frequently one named growth form suddenly changed to another growth form. Many of the specimens show the characteristics of 2 or 3 growth forms. Aonteuma Island: surge channel in leeward reef, 1 meter of water, 9 July, no. 8115B.

Leeward Reef: f. *triloba* and f. *elongata*, south end of reef, 26 July, no. 8249A; f. *renschii* and f. *elongata*, 26 July, no. 8249B; f. *elongata*, lagoon, north end of the reef on coral patch at 4.5 meters, 25 July, no. 8256A; f. *renschii* and f. *elongata*, seaward edge of reef at 1 meter, 4 August, no. 8272A; f. *elongata*, lagoon, 0.5 mile inshore of reef, on side and bottom of coral knoll to 6.5 meters, 9 August, no. 8318; North boat passage, f. *triloba*, lagoon, patch reef at north side of passage, 3 meters deep, 31 July, no. 8258; f. *elongata*, lagoon, south of passage on coral knoll, 14 August, no. 8398B. South Island: f. *elongata* and f. *triloba*, lagoon near 5 meter line opposite Aiaki village, on patch reef at 3.5 meters, 25 August, no. 8471. North Island: seaward reef, adrift in tide pool, 28 August, no. 8478.

HALIMEDA BIKINENSIS W. R. TAYLOR. This species, first described by Taylor (1950) from Bikini, was collected at only one location. This was in the deepest part of the lagoon, opposite the village of Aiaki, South Island. The bottom here was lime mud and sand with low, scattered, dead and living corals. The depth of water was 14.6 meters.

The plants grew to 15 and 18 cm. tall. The upper segments were flat, thin and reniform with an average width of 22 mm., but ranging from 15 to 30 mm., the average length was 14 mm., ranging from 10 to 16 mm. The plants were light yellow green in color on drying. The peripheral utricles were smaller than in Taylor's original description, 18 to 31 μ in diameter, 50 to 62 μ in height, separating easily on decalcification. The medullary filaments were fused in pairs at the nodes.

Lagoon: west of Aiaki village, bottom of low scattered, dead and living coral on lime mud and sand, 14.6 meters, 25 August, no. 8467.

HALIMEDA FRAGILIS W. R. TAYLOR. This species was also first described by Taylor from Bikini. Specimens were collected from the western reef on both the lagoon and seaward side, and on coral knolls. It was found growing in water 1 to 3 meters deep on lime sand and coral bottom.

The peripheral utricles were free and rounded after acid treatment. The average diameter was 31 μ, the length varies from 31 to 43 μ, the

greatest length was 62 μ. The medullary filaments pass through the nodes singly. The segments were paper thin and the type of branching produced a large more or less spherical mass.

Leeward reef: Lagoonside of the broad reef passage opposite Aiaki village in 1 to 1.8 meters of water, 26 July, no. 8246; West side of lagoon opposite Otoae village on coral knoll in 4 meters of water, 30 July, no. 8265; Seaward edge of Leeward reef, north of main boat passage, water depth 1.8 meters, 4 August, no. 272B; West side of lagoon, Leeward reef in 1 meter of water, 21 August, no. 8438.

Lagoon: West side between reef Rakai Teeka and Rakai Ati, 1.8 to 3.6 meters of water, 20 August, no. 8409.

HALIMEDA STUPOSA W. R. TAYLOR. This species was very abundant in the shallow, sandy, north portion of the lagoon and on the shallow, sandy, windward reef flats extending northeast of Aonteuma. It occurred as isolated individual plants. It was fairly common in the shallow areas covered with turtle grass (*Thalassia hemprichii*). In many of these habitats the plants were partly or entirely exposed at low tide. Only one collection was made on the leeward reef west of Aonteuma Island, in a surge channel.

The plants, excluding the stipe, were 4 to 8 cm. in height. The large stout stipe made up of rhizoids with sand and shell fragments bound into it, was 8 cm. long in one instance and 2.5 cm. wide. These rhizoidal stipes anchor the plant firmly in the rather loose substrate and were frequently broken in dislodging them. Four or five branches arise from the stipe and branch rapidly into a round globular mass. The segments were heavily calcified and became smaller and more terete in the uppermost branches.

The peripheral utricles separate on decalcification. Their diameter ranges from 25 to 40 μ and the length from 45 to 75 μ. The subcortical filaments were usually forked 3 or 4 times. The medullary filaments at the nodes were lightly joined into a common group with a few pores between the filaments.

Aonteuma Island: West of island in surge channel on reef, 9 July, no. 8115.

North Island: Lagoon, two hundred feet from the end of the jetty, sandy bottom, 25 July, no. 8221; Shallow lagoon in area of Thalassia north of jetty opposite village of Taneang, 5 August, no. 8277; Lagoon, west of Tekawa village, sand bottom, Thalassia patches, dry at low tide, 21 August no. 8426.

HALIMEDA TAENICOLA W. R. TAYLOR. This large and heavily calcified species was found growing on the leeward reef in surge channels and holes in the reef. Most of the specimens collected were in 1 to 3 meters of water. They were found growing with *H. opuntia*.

The plants averaged 9 to 10 cm. in height. The segments were heavily calcified and nitent. Three or four branches arose from a single upper seg-

ment. The segments near the base averaged 10 cm. wide by 5.5 cm. long, while those at the apex of the plant were 5 cm. wide by 4 cm. long. The peripherical utricles were from 43 μ to 60 μ in diameter. The subcortical utricles were inflated, not bullate, but funnel shaped and were up to 535 μ in length and 125 μ in diameter. The medullary filaments were joined at the nodes in pairs, closely adherent and tangled.

Aonteuma Island: In surge channel, reef west of Island, 1 to 3 meters of water, 9 July, no. 8116.

Leeward Reef: seaward edge of reef, north of boat passage, 1 to 3 meters of water, 4 August, no. 8270.

North Island: Windward reef flat at north end of island, 22 August, no. 8434.

HALIMEDA INCRASSATA (ELLIS) LAMOUROUX. The typical *incrassata* was found in shallow water of the northern part of the lagoon in areas almost dry at low tide.

Aonteuma Island: In bay-like area on sandy reef flat, northeast of the island, 9 July, no. 8113; Reef flat northeast of the island, almost dry at low tide, 9 July, no. 8481; Mud flat southeast of the island, in the lagoon, 11 August, no. 8359A.

HALIMEDA INCRASSATA (ELLIS) LAMOUROUX F. TRIPARTITA (BARTON) COLLINS. The f. *tripartita* was found in the deepest part of the lagoon at 14.6 meters with *H. bikinensis*, and on the seaward edge of the leeward reef in 1 to 3 meters of water.

The peripheral utricles varied between 39 μ and 56 μ in diameter, their length averaged 50 μ. The medullary filaments were attached at the nodes in a disk with pit openings between. The median segments averaged 10 mm. long by 6 mm. wide, those near the apex averaged 6 mm. in length and 5 mm. in width.

Leeward reef: North of the main boat channel, seaward edge of the reef, 1 to 3 meters, 4 August, no. 8271.

Lagoon: Deep basin opposite the village of Aiaki, 14.6 meters, 25 August, no. 8468.

CAULERPA

Three species of Caulerpa were collected on Onotoa. One of these, *C. urvilliana*, was present in many different marine habitats. Two species were found growing on sandy bottom, but trailing over dead coral and coralline algae. The third species was found only on coral rock. The horizontal rhizome in all species was attached at many places. The plants were usually heavily impregnated with sand, foraminifera shells and shell fragments; also small red algae such as Centroceros and Polysiphonia were growing on them epiphytically.

CAULERPA ELONGATA WEBER-VAN BOSSE. A very small species found grow-

ing very tightly attached to dead coral and coralline rocks. Its small size and very light color made it inconspicuous and it was probably frequently overlooked.

The horizontal rhizome was 0.3 to 0.5 mm. in diameter with erect foliar branches (assimilators) to 1 cm. tall. On the erect branches were rows of ramuli which branched dichotomously 1 to 4 times, ending in a mucronate apicula.

Leeward reef: On the lagoon side of reef, north side of the North passage, on coral rocks, 3 meters of water, 31 July, no. 8260; Middle of the southern pass, on coral rocks, 3 meters of water, f. *disticha*, 23 August, no. 8452; southeast end of reef, south of the point at the center of the Atoll, 10 August, no. 8401.

CAULERPA SERRULATA (FORSSKAL) J. AG. This species superficially resembles *C. urvilliana*, differing in the flat foliar branches with serrations only on two sides. The branches are usually spirally twisted around one margin. The plants are 1 to 3 cm. tall and in some specimens quite depauperate. A species of widely spreading habit, but not forming thick tufts. It was growing in shallow water on lime sand bottom, and was generally covered with sand, foraminifera shells and small epiphytic red algae. Some plants were growing in the turtle grass (Thalassia) patches. This species was also collected on Tarawa Atoll on the return trip to Kawjalein.

Central Lagoon: North Island, beyond the end of the jetty, sprawling over coral rocks, sand and foraminifera shells, 1 to 1.5 meters of water, 5 July, no. 8052; West of Tekawa village, in Thalassia patches on coarse lime-sand bottom, 21 August, no. 8425.

Tarawa Atoll: Island of Betio, western reef, 3 September, no. 8642.

CAULERPA URVILLIANA Montagne. The common species of the atoll was collected in all types of habitats. In the tide pools of the lagoon and the passes between the islands it was exposed at low tide. Plants were growing on the sheltered back slope of the coralline ridge where it was washed by the overflow of waves hitting the ridge front. It was found in the central lagoon to a depth of 6 meters. Then density of the plants varied and some sprawled in all directions with widely scattered foliar branches, while others had branches close together. It never formed extensive turfs.

The plants grew to 10 cm. tall in deep water but only 1 to 2 cm. in height in the tide pools. The foliar branches were beset with multiseriate apiculate ramuli. The color was yellowish when exposed in shallow tide pools and greener in deeper water. Most specimens were heavily covered with epiphytic red algae, foraminifera shells, tunicates and lime sand.

Aonteuma Island: On the leeward reef in a surge channel, rocky bottom, 9 July, no. 8100; Flats northeast of the Island, exposed at low tide, 21 August, no. 8423.

Lagoon: One half mile west of the North Island, sand and foraminifera bottom at 6 meters depth, 8 August, no. 8317; On a patch reef, less than 4 miles west from the village of Aiaki, depth of 2 meters, 30 July, no. 8255A. Leeward Reef: South end of reef, at north side of the north passage, f. *tristicha* growing with *Halimeda opuntia*, 26 July, no. 8249; Southeast end of the reef, on coral rocks, 20 August, no. 8408; Lagoon, inside reef, in 3 meters of water, 20 August, no. 8409; Seaward side of reef, lime-sand bottom at depth of 5 meters, largest specimens collected here, 10 cm. tall, 22 August, no. 8433.

North Island: Windward reef, in fissure on sheltered side of coralline ridge, 420 meters from the beach, 20 July, no. 8188, 8174; Reef flat in the lagoon at the south end of the island, in a rocky tide pool 100 meters from shore, exposed at low tide, 4 July, no. 8029; Lagoon, at the end of the jetty in water 1.5 meters deep at high tide, bottom of sand and foraminifera shells, 5 July, no. 8052; West of Tekawa village in lagoon on coarse lime-sand bottom in Thalassia patches, very depauperate and covered with small red algae, 21 August, no. 8425; Passage at south end of the island, on coral rocks, gravels and sand at 0.5 meters depth at low tide, in water flowing into the lagoon, 23 August, no. 8445.

Botany Department, Rutgers—State University of New Jersey

Literature Cited

Barton, E. S. 1901. The genus Halimeda. Siboga-Expeditie V. 60. E. J. Brill, Leyden.

Cloud, P. E., Jr. 1952. Preliminary report on geology and marine environment on Onotoa Atoll. Gilbert Islands. Atoll Research Bulletin. #13, 1952.

Gilbert, W. J. 1947. Studies on Philippine Chlorophyceae. III The Codiaceae. Bull. Torrey Club **74**: 121–132.

Moul, E. T. 1957. Preliminary report on the flora of Onotoa Atoll, Gilbert Islands, Atoll Research Bulletin 57, Pacific Science Board, National Research Council, Wash., D. C.

Setchell, W. A. 1928. Coral reefs as zonational plant formations. Science **68**: 119–121.

Taylor, W. R. 1950. Plants of Bikini and other Marshall Islands. Ann Arbor.

Yamada, Yukio. 1941. Species of the genus Halimeda from the South Seas. Science of the South Seas (Hagaku Nanyo) **4**: 12–25.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 86, No. 3, pp. 166–171 MAY, 1959

FRUITING GRIMMIA HARTMANII VAR. ANOMALA IN AMERICA[1]

ELVA LAWTON

By the published records *Grimmia hartmanii* var. *anomala* is a rare moss in America. According to Jones' treatment of Grimmia in Grout's Moss Flora of North America (1933) it was known from only one station in Idaho where fruiting specimens were collected by Leiberg in 1889 and described by E. G. Britton (1891) as *Grimmia Philbertiana*. Sterile plants were reported from Washington by Jones in 1935, from Michigan by Nichols in 1938, and from Alaska by Persson in 1947. The discovery of fruiting plants in Wyoming in 1953 and in Washington in 1956, and a check of specimens in the herbarium of the University of Washington indicate that this moss is not as rare in America as has been believed. The abundance and excellent condition of the capsules in the material collected recently permit a full description of the plant and a better understanding of its variations.

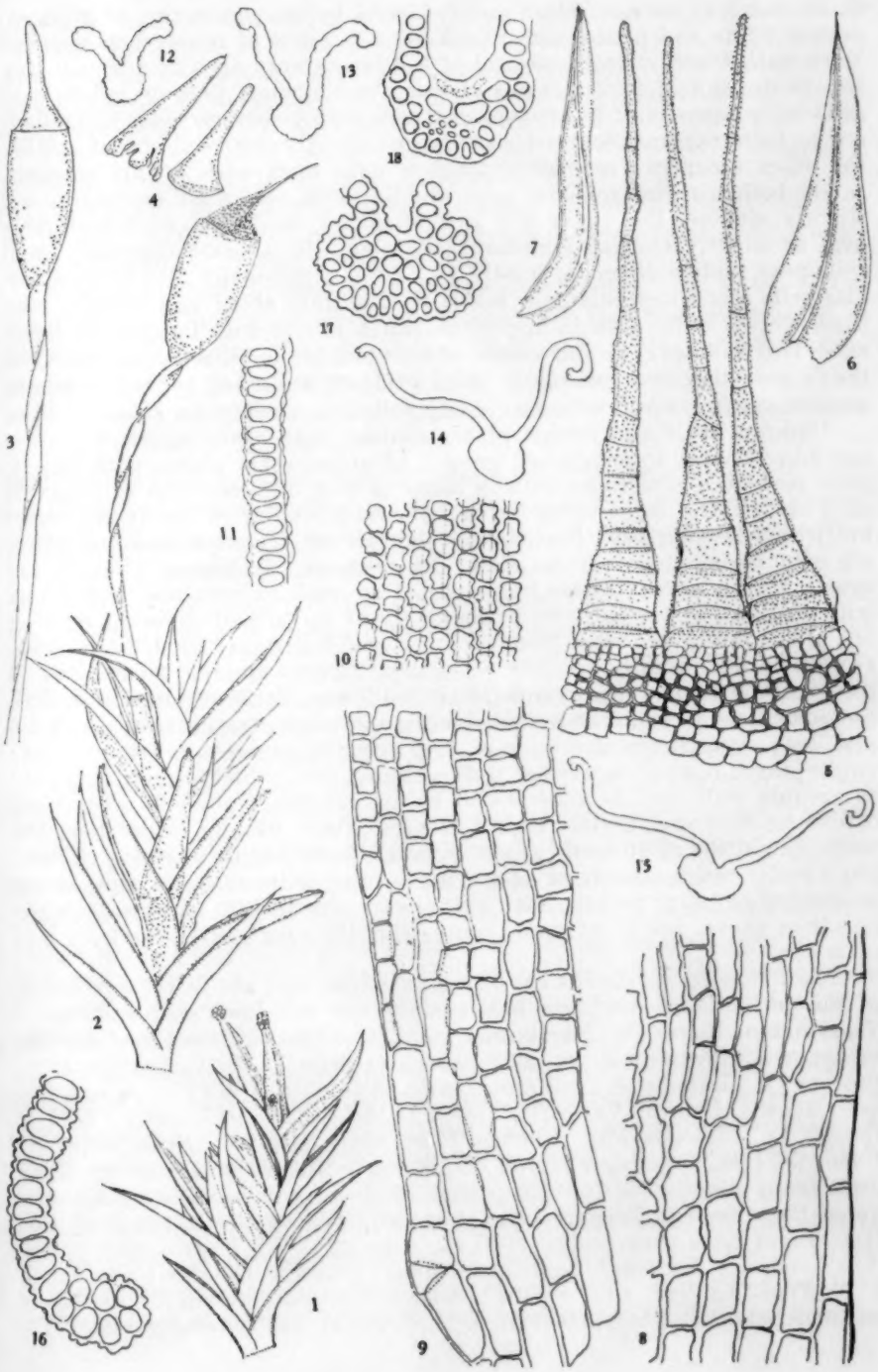
Grimmia hartmanii var. *anomala* (Hampe) Moenk. Laubm. Eur. 369. 1927. *Grimmia anomala* Hampe in Schimp. Syn. Musc. Eur. ed. 2. 270. 1876. *Grimmia Philbertiana* E. G. Britton, Bull. Torrey Club 18: 51–52. 1891. *Grimmia phyllantha* Lindb. in Broth. Enum. Musc. Caucasi 83–84. 1892. *Grimmia elatior* subsp. *anomala* Kindb. Eur. & N. Am. Bryin. 222. 1897. *Dryptodon anomalus* Loeske, Hedwigia 49: 32. 1910. *Rhacomitrium phyllanthum*. Warnst. Hedwigia 53: 306. 1913. *Grimmia Hartmanii* var. *alpinoborealis* Loeske, Laubm. Eur. 1: 141. 1913. *Grimmia Hartmanii* subsp. *anomala* Loeske, Mon. Eur. Grimm. 182. 1930.

Plants dark green with older parts becoming brown, 1–5 cm. long but usually about 2 cm., stem with central strand of a few small, thin walled cells. Leaves imbricate or slightly contorted when dry, spreading when moist, 1.8–2.5 × .45–.63 mm., lanceolate, keeled above, concave below; apex acuminate and without hairpoint or with a short hyaline, toothed hairpoint

[1] This study was supported by a grant from the Biological and Medical Research Fund of the State of Washington.

The author is very grateful to the New York Botanical Garden and the University of Washington for the opportunity to study herbarium specimens.

FIGS. 1–17. *Grimmia hartmanii* var. *anomala*, Lawton 3329. FIG. 1. Male plant with antheridial bud and gemmae. × 15. FIG. 2. Female plant with moist capsule showing seta slightly arcuate and an undeveloped sporophyte lower on stem. × 15. FIG. 3. Dry capsule with straight seta. × 15. FIG. 4. Calyptra and operculum. × 15. FIG. 5. Part of peristome. × 180. FIGS. 6 & 7. Leaves. × 20. FIG. 8. Cells from leaf base adjacent to midrib at right. × 365. FIG. 9. Alar cells. × 365. FIG. 10. Upper median leaf cells. × 365. FIG. 11. Longitudinal section of upper leaf cells. × 365. FIGS. 12–15. Cross sections of leaves from apex to base. × 82. FIG. 16. Cross section of leaf margin below apex. × 365. FIG. 17. Cross section of midrib near middle of leaf. × 256. FIG. 18. *Grimmia hartmanii*, Rabenh. Bryoth. Eur. 465b. Cross section of midrib near middle of leaf. × 256.


12
13
18
4
7
17
6
3
14
11
10
5
15
2
16
1
9
8

to .35 mm. long, or apex blunt and deformed by the production of gemmae; midrib terete and prominent at back, of 4–5 layers of nearly homogeneous thick walled cells at leaf base and of 3–4 layers near apex; margins bistratose in upper half to two thirds of leaf, the bistratose part of 1–6 rows of cells but commonly of 1–3 rows, sometimes with bistratose spots in lamina; one or both margins recurved, usually one slightly recurved at leaf middle, the other recurved from above base to near apex with a part revolute, rarely both margins revolute near middle; cells somewhat incrassate and slightly sinuose, the upper 6–9 μ in diameter, isodiametric, transversely oval or slightly elongate; median cells about 10 μ, some elongate; basal cells near midrib elongate, mostly 10×20 μ, occasionally 10×30 μ, a few alar cells sometimes enlarged, becoming quadrate above and usually with thicker cross walls; cells in upper two thirds of leaf with irregularly thickened, longitudinal cuticular ridges which resemble papillae in cross section, the ridges either over cell cavity or on adjacent walls, 1–2 per cell. Gemmae common, green to yellow-brown, many celled, in clusters on tips of leaves.

Dioicous, male and female plants similar; sex organs apical but often becoming lateral by continued growth of stem; male plants with one or more perigonia, sometimes with as many as 8 of different ages at intervals on a plant 2 cm. long; outer perigonial bracts similar to vegetative leaves but with a broader base, inner bracts shorter, very concave, margins plane, all with midribs; antheridia about 12, without paraphyses. Perichaetial bracts similar to the leaves but more often with hair points, archegonia without paraphyses; capsules borne singly or up to 4 of different ages on one plant, rarely two setae from the same perichaetium; seta 3–5 mm. long, twisted to left, usually straight when dry, slightly arcuate when moist or sometimes straight; urn symmetrical, 1–1.5 mm. long, commonly smooth but sometimes irregularly wrinkled when dry; calyptra mitrate, about 1.3 mm. long; operculum about 1 mm. long, with a straight or oblique beak; two or three rows of somewhat differentiated cells which remain attached to capsule wall may be interpreted as an annulus; columella excurrent, extending .8–.9 mm. beyond mouth of capsule and usually longer than the teeth; peristome of 16 teeth which are variable in length, reaching .7 mm., but usually much shorter or appearing so due to breaking of tips, entire or divided to below middle, with about 5 transverse bars at base, strongly papillose above, less so at base; spores slightly roughened, about 13 μ in diameter.

The following specimens have been examined and are in the herbarium of the author or in herbaria indicated by the standard abbreviations:—Washington: Pierce Co., Mt. Rainier, road from Longmire to Paradise, near bridge over Nisqually River, 3900 ft., c. fr., July 14, 1956, *Lawton 3329;* Cowlitz Co., Kalama, c. fr. *Ethan Smith,* Apr. 1930 (WTU); Skagit Co., near Monte Cristo and Verlot, c. fr., Oct. 11, 1953, *Becking 5310502* (WTU); Chelan Co., Cascade Mts., Stevens Pass, 4000 ft., *T. C. Frye,* Sept. 10, 1929 (WTU). Wyoming:—Teton Co., Teton National Park, Cascade Trail near Jenny Lake, 6760 ft., c. fr., Aug. 14, 1953, *Lawton 1759;* Teton National Park, trail to Taggart Lake, Aug. 13, 1953, *Lawton 1738;* Park Co., Bear Tooth Lake near Lodge, 9000 ft., Aug. 20, 1953, *Lawton 1949.* Montana:—Glacier National Park near Many Glaciers Hotel tourist camp. *T. C. Frye,* July 12, 1934 (WTU). Idaho:—divide between Traille River and Independence Creek, 6000 ft., c. fr., Sept. 27, 1889, *Leiberg 219* (NY).

Norway:—S. Norway, wall near Eide, *Dixon & Nicholson,* July 24, 1900 (WTU); Seljestad, on a wall, *Dixon & Nicholson,* July 21, 1900 (NY); Svolvaer, ad rupes maritimas, *Holzinger, Musci Acro. Bor.-Amer. 339,* c. fr., (NY, WTU). Austria:—Carinthia, Glockner, House, *Dixon & Nicholson,* Aug. 1904 (WTU). Schweiz; Kanton Wallis, *Bauer, Musci Eur. 993a* (WTU); Kanton Bern, *Bauer, Musci Eur. 993b* (WTU). Iceland:—Isafjördhur, July 11, 1914, *A. L. Andrews 51* (NY).

Reported by Nichols (1938) from Michigan, Marquette Co., Huron Mt.; by Persson (1947) from Alaska, E. Pacific Coast, Haencke Is., Disenchantment Bay, 400 ft., H. Stair Mazaika 5232.

This moss which is common in Europe was known only in the sterile condition until 1891 when Mrs. Britton described the capsules collected in Idaho by Leiberg. In 1900 Dixon and Nicholson (1904) found fruiting plants in Norway. According to Mrs. Britton the teeth are entire but Dixon and Nicholson say they are either entire or slightly divided above. Figure 5 drawn from the Mt. Rainier plants, no. 3329, shows entire teeth, but many of the fruiting plants from Wyoming have the teeth divided to below the middle, and some capsules of Leiberg's plants show a slight division of the teeth. The capsules of the other collections of fruiting plants were either too young or too old for accurate observations on the teeth. In no. 1759 the teeth were .7 mm. long, nearly as long as the operculum. The upper part of the peristome layer is less well developed in some plants and parts of the peristome are often found attached to the apex of the excurrent columella, with the teeth apparently only about .25–.3 mm. long. Similar variations have been observed or reported for *Grimmia hartmanii.*

Limpricht (1890) states that in *G. hartmanii* there is one row of stomata at the base of the capsule, and this was observed in the plants at the New York Botanical Garden from Corsica which were described by Philbert (1887), but the stomata are not in a straight line. In the variety *anomala* the stomata are more numerous and are in at least two rows.

Salmon (1900) discussed the differences between *G. hartmanii* and the var. *anomala,* pointing out that the leaves of the species are longer, up to 4 or 5 mm., narrower, more gradually narrowed to apex, cells smooth and with walls thicker and more sinuose, the basal leaf cells longer and the stem without a central strand. *G. hartmanii* is generally described as having smooth leaves while those of the variety *anomala* are said to be papillose. Loeske (1930) makes clear that the thickenings on the leaf cells are not papillae in the usual sense but longitudinal striae of cuticular thickenings which are not uniform in height and give the appearance of papillae of different sizes in a leaf cross section. Salmon shows the leaf cells with longitudinal lines in his figure 8, but he describes the thickenings as papillae. In his discussion of the European variety *montenegrina* Breidler & Szysz., Loeske points out that the leaves are not entirely smooth near the leaf apex.

The midrib of the leaf as seen in cross section shows differences in struc-

ture valuable in differentiating between *G. hartmanii* and var. *anomala*. Figures 17 and 18 of var. *anomala* and *G. hartmanii*, respectively are from sections near the middle and show the following differences; in *G. hartmanii* the midrib is less rounded and less prominent, has definite guide cells and a band of much smaller cells with very thick walls. In the var. *anomala* the cells are more nearly uniform in size and thickness of wall. Limpricht (1890) described guide cells and an angled midrib for both, but my observations on American and European material do not confirm this for the variety. Salmon (1900) illustrates the midrib of var. *anomala* as rounded and without definite guide cells.

In *G. hartmanii* the brood bodies are on small, thin, deformed leaves which are mostly pointed at the apex. My observations on the var. *anomala* indicate that the leaves bearing brood bodies are not thinner, and while they are deformed at the apex they are more often blunt or retuse than pointed. Gemmae or brood bodies have been found both on plants bearing antheridia and on plants with capsules, but they are more abundant on sterile plants.

In the herbarium of the New York Botanical Garden there is a sterile specimen of *Grimmia hartmanii* collected June 7, 1890 by Mrs. Britton in Virginia, Bedford Co., Blue Ridge Mts., Peaks of Otter, in crevices of shaded rocks at the spring with *Swartzia montana*. The label is in the handwriting of Mrs. Britton and in the envelope she left a note saying that the stem is without a central strand. The leaves are without papillae and in other characteristics the specimen checks with plants of the species from Europe. I have not been able to find any record in the literature of this collection of *G. hartmanii* which is very rare in America.

HUNTER COLLEGE
NEW YORK 21, N.Y.

Literature Cited

Britton, E. G. 1891. Contributions to American Bryology II. A supplementary enumeration of the mosses collected by Mr. John B. Leiberg in Idaho. Bull. Torrey Club **18**: 49–56.

Dixon, H. N. & Nicholson, W. E. 1904. Bryological notes on a trip to Norway. Nytt Magazin for Naturvidenskaberne **42**: 91–108.

Hampe, E. 1876. In Schimper, W. P. Synopsis Muscorum Europaeorum. ed. 2. Stuttgart.

Jones, G. N. 1933. Grimmiaceae. In A. J. Grout, Moss Flora of North America north of Mexico. **2**: 41–42.

———— 1935. A note of the occurrence of *Grimmia hartmanii* var. *anomala* in Washington. Bryologist **38**: 46–47.

Kindberg, N. C. 1897. European and North American Bryineae. Linkoeping.

Limpricht, K. G. 1890. Die Laubmoose Deutschlands, Oesterreichs und der Schweiz. I. Leipzig.

Lindberg, S. O. 1892. In Brotherus, V. F. Enumeratio muscorum Caucasi. Acta Sci. Fennicae, **19**(12): 1–170.

Loeske, L. 1910. Zur Moosflora der Zillertaler Alpen. Hedwigia **49**: 1–48.
————. 1913. Die Laubmoose Europas. I. Grimmiaceae.
————. 1930. Monographie der europäischen Grimmiaceen. Bibl. Bot. 101.
Moenkemeyer, Wilh. 1927. Die Laubmoose Europas. Leipzig.
Nichols, G. E. 1938. Bryophytes of the Huron Mountain Region, Marquette Co., Michigan. Bryologist **41**: 25–31.
Persson, H. 1947. Further notes on Alaskan-Yukon Byrophytes. Bryologist **50**: 297.
Philibert, Henri. 1887. La fructification du Grimmia hartmanii. Revue Bryol. **14**: 49–52.
Salmon, E. S. 1900. Grimmia anomala Hpe. mss. Schpr. Revue Bryol. **27**: 33–36.
Warnstorf, C. 1913. Zur Bryo-Geographie des Russischen Reiches. Hedwigia **53**: 184–320.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 86, No. 3, pp. 172–183 MAY 1959

GEOGRAPHICAL DISTRIBUTION OF CHARACEAE[1]

R. D. WOOD AND K. IMAHORI

Information concerning the general distribution of individual species of any group of organisms is frequently needed by students and specialists. This is especially true in a group such as the Characeae in which the literature is so scattered. The writers have, therefore, attempted to assemble data for each extant species of the Charophyta. Distribution is indicated for the continents in which each occurs. In the case of geographically restricted species, the country is also stated. The nomenclature follows the senior writer's earlier (Wood 1952) review, augmented from the junior author's work (1954). Data were drawn from original descriptions, Braun and Nordstedt's (1882) world compilation, "die Fragmente," or from the numerous regional monographs listed at the end of this paper. Almost all data from species occurring in more than one continent were obtained from three works, those of Corillion (1957), J. Groves and G. R. Bullock-Webster (1920, 1924), and Zaneveld (1940). It is possible that some records of species distribution from less conspicuous journals may not have come to the writers' attention in time for inclusion. The data have been assembled on punched cards as described earlier (Wood 1957).

The first extensive tabulation of the distribution of species of the world was by Alexander Braun in 1867, while the most complete treatment of the species remains the compilation of Braun's works together with a key and notes by Nordstedt (Braun and Nordstedt 1882). Other extensive treatments of Characeae have been of a regional nature, and tabulations of distribution of species have been restricted to the species of the region under investigation, e.g., Zaneveld (1940) for Malaysia; Imahori (1951, 1954, 1955) for Formosa, Japan, and the Ryukyu Islands. In the present work the writers include the general distribution of all the species of Characeae recognized in the literature as of January 1, 1958.

This list is designed for use with the lists for gametangial constants of extant Charophyta for micropaleobotany (Wood 1959). Nomenclatural references occur in the senior author's earlier list (Wood 1952) for which the present work provides long-needed geographical data.

GEOGRAPHICAL DISTRIBUTION OF EXTANT CHAROPHYTA

Chara abnormiformis Vilh.—rare—ASIA: Russian Turkestan
C. aculeolata Kütz. ex Reich.—comm.—EUROPE; AFRICA: north; ASIA: west[2]

[1] Supported in part by the Research Fund of the College of Arts and Sciences of the University of Rhode Island; and in part by a grant G-2517 of the National Science Foundation, 1956–57.

C. altaica A. Br.—rare—ASIA: southern Altai Mts.
C. amplexa J. Gr. & Steph.—rare—AFRICA: south
C. arcuatofolia Vilh.—rare—ASIA: Russian Turkestan
C. arrudensis Mendes—rare—EUROPE: Portugal
C. aspera Deth. ex Willd.—comm.—EUROPE; AFRICA: north; ASIA: north; N. AMERICA
C. australis R. Br.—comm.—ASIA: south; AUSTRALIA: New Zealand
C. baltica (Hartm.) Fr. ex Aspegr.—comm.—EUROPE: west central, especially Baltic coasts; AFRICA: north; N. AMERICA: Greenland; S. AMERICA: Bolivia[?]
C. baueri A. Br.—occ.—EUROPE: central; AUSTRALIA
C. bohemica (Vilh.) Vilh.—rare—EUROPE: Czechoslovakia
C. brachypus A. Br.—comm.—AFRICA; ASIA: south, through Philippines and East Indies; AUSTRALIA
C. braunii Gm.—cosmopolitan
?*C. brionica* Stapf—rare—EUROPE: Island of Brionica, Italy
C. brittonii T.F.A. ex Rob.—rare—N. AMERICA: U.S.A. (N.J., Ind.)
C. buckellii G.O.A.—rare—N. AMERICA: Canada (B.C.)
?*C. burmanica* Pal—rare—ASIA: Burma
C. canescens Desv. in Lois.—comm.—EUROPE; AFRICA: north; ASIA; N. AMERICA: east and west coasts
?*C. capensis* Meyer ex Kütz.—rare—AFRICA: Cape
C. chrysospora J. Gr. & Steph.—rare—AFRICA: Cape
C. compacta Rob. [= *C. sejuncta*]—rare—N. AMERICA: U.S.A. (N.Y.)
C. concinna Durieu—rare—AFRICA: Algeria
C. conimbrigensis G. da C.—rare—EUROPE: Portugal
C. connivens Salz. ex A. Br.—occ.—EUROPE; AFRICA: north; ASIA: southwest
C. contraria A. Br. ex Kütz.—cosmopolitan
C. corallina Kl. ex Willd.—comm.—AFRICA: Mauritius; ASIA: south, through India, E. Indies, Philippines; AUSTRALIA: New Caledonia
C. corfuensis Gr. ex F.—rare—EUROPE: Greece (Corfu I.)
C. coronatiformis Rob.—rare—N. AMERICA: U.S.A. (Mich.)
C. crinitiformis Rob.—rare—N. AMERICA: U.S.A. (N.Y.)
C. cubensis [= *C. zeylanica*]—rare—N. AMERICA: Cuba
C. curtissii T.F.A. ex Rob.—rare—N. AMERICA: U.S.A. (Fla.)
C. delicatula [= *C. globularis*]—comm.—EUROPE; AFRICA: south; ASIA; N. AMERICA
C. denudata A. Br.—rare—EUROPE: south; AFRICA: Cape
C. desmacantha J. Gr.—rare—EUROPE: north central (Eng., Swed., Germ.); AFRICA: Morocco
C. disjuncta (Nordst.) Trab. ex Feldm.—rare—AFRICA: Algeria
C. domini Vilh.—rare—ASIA: Russian Turkestan
C. drummondii A. Br.—rare—AUSTRALIA: west
C. ecklonii A. Br.—rare—AFRICA: Cape
C. erythrogyna Griff.—rare—ASIA: southern India, Burma, Malaysia
C. evoluta T.F.A.—occ.—N. AMERICA: U.S.A. and Canada
C. excelsa T.F.A.—occ.—N. AMERICA: U.S.A.

[2] Reported by Corillion (1957: 193) for N. and S. America, but he did not cite reference or specimen.

C. fibrosa Ag. ex Bruz.—comm.—AFRICA; ASIA: south; AUSTRALIA
C. filicaulis Rob. [= *C. zeylanica*?]—rare—N. AMERICA: U.S.A. (Fla.)
C. filiformis Hertz.—occ.—EUROPE: northwestern (Germ., Swed., Russ., Lat.)
C. fischeri Mig.—rare—ASIA: southwest (Uzbekistan)
C. formosa Rob. [= *C. scjuncta*]—occ.—N. AMERICA: U.S.A. (N.J. to Iowa)
C. fragifera Durieu—occ.—EUROPE; AFRICA: Tunisia, Cape; ASIA
C. fulgens F.—rare—ASIA: Dutch E. Indies (Bali)
C. galioides D.C.—occ.—EUROPE; AFRICA: north
C. globata Mig.—rare—ASIA: east, China
C. globularis Thuil.—cosmopolitan, extending into arctic
C. gobiana Vilh.—rare—ASIA: Mongolia
C. grovesii Pal—rare—ASIA: Burma
C. gymnopitys A. Br. — comm. — AFRICA; ASIA; AUSTRALIA; [?]OCEANIA; [?]N. AMERICA
C. handae Pal—occ.—ASIA: Burma
C. hansenii (Sond.) Ophel—rare—EUROPE: Schleswig-Holstein
C. hatei Dixit—rare—ASIA: India
C. hereroensis Nordst.—rare—AFRICA: German Southwest
C. hippelliana Vilh.—rare—EUROPE: Czechoslovakia
C. hirsuta T.F.A.—rare—N. AMERICA: western U.S.A. (Cal., Neb.)
C. hispida L.—comm.—EUROPE; AFRICA: north; ASIA: Siberia
C. hornemannii Wallm.—comm.—N. AMERICA: southern U.S.A., Mexico, W. Indies; S. AMERICA: through Brazil
C. hungarica F.—rare—EUROPE: Hungary
C. hydropitys Reich.—comm.—AFRICA; ASIA; N. AMERICA; S. AMERICA
C. hypnoides Rob.—rare—N. AMERICA: Canada (Ont.)
C. imperfecta A. Br.—occ.—EUROPE: south; AFRICA: north
C. inconnexa T.F.A.—rare—N. AMERICA: central U.S.A. (Iowa)
C. inermis Zanev.—rare—ASIA: Malaysia
C. infirma A. Br.—rare—ASIA: India, Iran, Afghanistan
C. intumescens Rob.—occ.—N. AMERICA: Canada, Gaspé through U.S.A. to Mexico
C. javanica A. Br.—rare—ASIA: E. Indies, Java
C. kenoyeri Howe—rare—S. AMERICA: Panama
C. keukensis (T.F.A.) Rob.—occ.—N. AMERICA: central U.S.A. and Canada
C. kieneri Daily—occ.—N. AMERICA: central U.S.A.
C. kirghisorum Less.—rare—ASIA: central, Kirghis steppes
C. kraussiana J. Gr.—comm.—AFRICA: Cape
C. lamyana S.-R.—rare—EUROPE: France (Haut-Vienne)
C. leiopitys Whelden—rare—S. AMERICA: Argentina
C. leptopitys A. Br.—occ.—AUSTRALIA
C. leptosperma A. Br.—rare—N. AMERICA: Mexico
?*C. longifolia* Rob.—occ.—N. AMERICA: central U.S.A.
C. mauretanica Feldm.—rare—AFRICA: Algeria
C. mollusca A. Br.—occ.—AUSTRALIA: Tasmania
C. morongii Rob.—rare—N. AMERICA: central U.S.A. (Mich.)
?*C. mucronata* F. (nom. illeg.)—rare—EUROPE: Hungary

C. muscosa J. Gr.—rare—EUROPE: Ireland
C. myriophylla A. Br.—rare—AUSTRALIA: Tasmania
?*C. nordhoffiae* (T.F.A.) Rob. [= *C. hornemannii*]—rare—N. AMERICA: western U.S.A. (Calif.)
C. nuda Pal—rare—ASIA: Burma
C. oedophylla Feldm.—rare—AFRICA: Tunisia
C. pallida Rob. [= *C. braunii*]—occ.—N. AMERICA: southern U.S.A. to central Mexico
C. palmeri Wood—rare—N. AMERICA: Mexico
C. papillosa Kütz.—occ.—EUROPE: north; ASIA: west; [?]N. AMERICA; [?]S. AMERICA
C. pashanii Dixit—rare—ASIA: India
C. pelosiana Avetta—rare—EUROPE: Italy
?*C. phaeochiton* A. Br.—rare—AFRICA: Cape
C. pistianensis Vilh.—rare—EUROPE: Czechoslovakia
C. poopoensis G.O.A.—rare—S. AMERICA: Bolivia
C. pseudo-brachypus J. Gr.—occ.—AFRICA: Natal, S. Rhodesia
C. rusbyana Howe—comm.—S. AMERICA: Brazil, Argentina, Bolivia
C. salina Schur—rare—EUROPE: Austria
C. sanctae-margaritae (T.F.A.) Rob. [= *C. zeylanica*]—rare—N. AMERICA: western U.S.A. (Calif.)
C. scepusiensis F.—rare—EUROPE: Czechoslovakia
C. schaffneri (A. Br.) T.F.A.—rare—N. AMERICA: Mexico
C. schroederi Mig.—rare—AFRICA: Nairobi
C. sejuncta A. Br. — comm. — N. AMERICA: U.S.A. southward; S. AMERICA
C. sibirica Mig.—rare—ASIA: Siberia
C. socotrensis Nordst. in Kuhn—rare—AFRICA: Socotra I.
C. stachymorpha Gant.—occ.—AFRICA: Cape
C. strigosa A. Br.—occ.—EUROPE; AFRICA: north
C. submollusca Nordst.—rare—AUSTRALIA: Queensland
C. succincta A. Br.—comm.—AFRICA: Libya, Mauritius I.; ASIA: India; AUSTRALIA: New Caledonia[?]
C. tanyglochis H. & J. Gr.—rare—AFRICA: Cape Peninsula
C. tenera Hasslow—rare—ASIA: China ("Sinkang")
C. tenuispina A. Br.—occ.—EUROPE: north
C. tomentosa L.—comm.—EUROPE; AFRICA: north; ASIA
?*C. verticulata* Hate [= *C. zeylanica*]—ASIA: India
C. vulgaris Vaill. ex L.—cosmopolitan
C. wallichii A. Br.—occ.—ASIA: India, Burma
C. zeylanica Klein ex Willd.—comm.—AFRICA: south; ASIA: south; AUSTRALIA; OCEANIA (Hawaii); N. AMERICA; S. AMERICA
Lamprothamnium aragonensis (Prósp.) G. da C.—rare—EUROPE: Spain
L. carrissoi G. da C.—rare—EUROPE: Portugal
L. macropogon (A. Br.) Ophel—rare—AUSTRALIA: Swan River
L. papulosum (Wallr.) J. Gr.—comm.—EUROPE; AFRICA
L. tolelanus (Prósp.) Wood—rare—EUROPE: Spain
Lychnothamnus barbatus (Meyen) Leonh.—occ.—EUROPE; ASIA: India
Nitella abyssinica A. Br.—rare—AFRICA: Ethiopia
N. acuminata A. Br. ex Wallm.—comm.—AFRICA; ASIA: India, Malaysia to Japan; N. AMERICA; S. AMERICA

N. allenii Imah.—rare—ASIA: Japan
N. alleninda Zanev.—occ.—ASIA: Malaysia (Java)
N. annandalei Pal—rare—ASIA: Burma
N. annularis T.F.A.—rare—N. AMERICA: Mexico
?*N. anomala* Wallm.—[?]EUROPE: Spain
N. arechavaletae Speg.—occ.—S. AMERICA: Uruguay, Brazil
N. asagrayana Schaffn. ex Nordst.—rare—N. AMERICA: Mexico
N. axillaris A. Br.—comm.—ASIA: India, Malaysia; N. AMERICA: U.S.A., Mexico, Cuba; S. AMERICA: Venezuela
N. axilliformis Imah.—occ.—ASIA: Japan, Formosa
N. axillocarpa J. Gr.—rare—AFRICA: Portuguese East
N. baronii H. & J. Gr.—rare—AFRICA: Madagascar
N. bastinii T.F.A.—rare—N. AMERICA: U.S.A. (Ill.)
N. bengalensis Kundu—rare—ASIA: India (Calcutta)
N. bipartita F.—rare—ASIA: Malaysia (Java, Sumatra)
N. blankinshipii T.F.A.—rare—N. AMERICA: U.S.A. (Mo.)
N. blowiana J. Gr.—rare—AFRICA: Madagascar
N. bonaërensis Speg.—rare—S. AMERICA: Argentina
?*N. brachyteles* A. Br.—occ.—EUROPE: south; AFRICA: north
N. burmanica Pal—rare—ASIA: Burma
N. californica T.F.A.—occ.—N. AMERICA: U.S.A. (Calif.)
N. capillaris (Krok.) J. Gr. & B.-W.—comm.—EUROPE; AFRICA: north; ASIA: west; [?]N. AMERICA
N. capillata A. Br.—occ.—N. AMERICA: southern U.S.A.
N. capitellata A. Br.—occ.—N. AMERICA: southeastern U.S.A.
?*N. capitulifera* T.F.A.—occ.—ASIA: Japan, Formosa
N. cernua A. Br.—occ.—N. AMERICA: West Indies
N. clavata Kütz.—comm.—N. AMERICA: western U.S.A.; S. AMERICA
N. comptonii J. Gr.—occ.—AUSTRALIA: Queensland, New Caledonia
N. confervacea A. Br.—occ.—EUROPE; ASIA: west; AUSTRALIA; N. AMERICA
N. conformis Nordst.—rare—AUSTRALIA: New Zealand
N. congesta (R. Br.) A. Br.—occ.—AUSTRALIA: west, Tasmania, New Zealand[?]
N. conifera J. Gr. & Steph.—rare—AFRICA: Cape
N. coreana Morioka—rare—ASIA: Korea
N. crispa Imah.—rare—ASIA: Japan
N. cristata A. Br.—rare—AUSTRALIA
N. dictyosperma H. & J. Gr.—rare——N. AMERICA: West Indies (Antigua); ASIA: Burma
N. diffusa A. Br.—occ.—AUSTRALIA: Tasmania, Queensland
N. dilatata T.F.A.—rare—N. AMERICA: Canada (Ont.)
N. dimorpha Mig.—rare—ASIA: Japan
N. divaricata J. Gr. & Steph.—rare—AFRICA: Transvaal
N. dixonii H. & J. Gr.—rare—EUROPE: Portugal
N. doidgeae J. Gr. & Steph.—rare—AFRICA: Transvaal
N. dregeana Kütz.—rare—AFRICA: Cape
N. dualis Nordst.—occ.—AFRICA: Liberia; ASIA: Indo-China
N. duthieae J. Gr. & Steph.—rare—AFRICA: S. Rhodesia
N. elegans Pal—rare—ASIA: Burma

N. erecta Imah.—rare—ASIA: Japan
N. expansa T.F.A.—rare—ASIA: Japan
N. fallosa Morioka—rare—AFRICA: Madagascar[?]; ASIA: Japan
N. fascicularis F. & G.O.A. ex F.—rare—ASIA: Malaysia
N. flagellifera J. Gr. & G.O.A.—occ.—ASIA: India, Japan
N. flagelliformis A. Br.—occ.—ASIA: India, Japan
N. flexilis (L. pp.) Ag.—comm.—EUROPE; AFRICA; ASIA; N. AMERICA; S. AMERICA
N. furcata (Roxb. ex Bruz.) Ag.—comm.—AFRICA; ASIA, AUSTRALIA: northeast: [?]N. AMERICA; [?]S. AMERICA.
N. gelatinosa A. Br.—rare—AUSTRALIA: Queensland
N. globulifera Pal—rare—ASIA: Burma
N. gloeostachys A. Br.—rare—AUSTRALIA: Swan River
N. gracilens Morioka—rare—ASIA: Japan
N. graciliformis J. Gr.—occ.—AFRICA: Madagascar; ASIA: Japan[?]
N. gracilis (Sm.) Ag.—cosmopolitan
N. gracillima T.F.A.—rare—ASIA: Japan
N. grovesii Kundu—occ.—ASIA: India
N. guineensis Kütz.—rare—AFRICA: Guinea
N. habrocoma J. Gr. & Steph.—rare—AFRICA: Transvaal
N. heterodactyla F. & G.O.A. ex F.—rare—AFRICA: German East
?*N. heterophylla* (A. Br.) A. Br.—rare—AUSTRALIA: Adams River
N. heteroteles J. Gr. & Steph.—rare—AFRICA: Madagascar
N. hookeri A. Br.—occ.—AUSTRALIA: Tasmania, S. Australia, New Zealand: ANTARCTICA: Kerguelen
N. horikawae Imah.—rare—ASIA: Japan
N. hyalina (D.C.) Ag.—cosmopolitan
N. inaequalis J. Gr.—rare—AFRICA: Madagascar
N. intermedia Nordst. in T.F.A.—occ.—N. AMERICA: northeastern U.S.A.
N. inversa Imah.—rare—ASIA: Japan
N. japonica T.F.A.—rare—ASIA: Japan
N. knightiae J. Gr. & Steph.—rare—AFRICA: S. Rhodesia
N. laxa T.F.A.—comm.—EUROPE; ASIA; N. AMERICA
N. lechleri A. Br. ex Horn af Rantzien—occ.—S. AMERICA: Chile
N. leibergii T.F.A.—occ.—N. AMERICA: western U.S.A.
N. leonhardii Wood—rare—AUSTRALIA: New Zealand
?*N. leptoclada* A. Br.—rare—AFRICA: Angola
N. leptodactyla J. Gr.—occ.—AFRICA: Madagascar; ASIA: Ceylon, Japan, India
N. leptosoma Nordst.—rare—AUSTRALIA: New Zealand
N. leptostachys A. Br.—rare—AUSTRALIA: Swan River
N. lhotzkyi (A. Br.) A. Br.—rare—AUSTRALIA: Queensland
?*N. longifurca* (Rupr.) Kütz.—rare—ASIA: Songaria (Russia?)
N. macounii T.F.A.—occ.—N. AMERICA: Canada, U.S.A.
N. madagascariensis Zanev.—rare—AFRICA: Madagascar
?*N. mauritiana* A. Br.—rare—AFRICA: Mauritius
N. megacarpa T.F.A.—occ.—N. AMERICA: eastern U.S.A.
N. mexicana T.F.A.—rare—N. AMERICA: Mexico

N. microcarpa A. Br.—comm.—AFRICA; ASIA; AUSTRALIA; N. AMERICA; S. AMERICA
N. microphylla A. Br.—rare—AUSTRALIA: Swan River
N. minuta T.F.A.—rare—N. AMERICA: eastern U.S.A. (N.J.)
N. mirabilis Nordst. ex J. Gr.—occ.—ASIA: China, India
?*N. missouriensis* T.F.A.—N. AMERICA: U.S.A. (Mo.)
N. moniliformis Zanev.—rare—ASIA: Malaysia (Java)
N. monodactyla A. Br.—rare—S. AMERICA: Bolivia
N. montana T.F.A.—rare—N. AMERICA: U.S.A. (Mont.)
N. moriokae Wood—rare—ASIA: Japan
N. morongii T.F.A.—occ.—N. AMERICA: eastern U.S.A.
N. mucronata (A. Br.) Miq.—comm.—EUROPE; AFRICA; ASIA; N. AMERICA; S. AMERICA
N. multipartita T.F.A.—rare—ASIA: Japan
N. musasiensis Morioka—rare—ASIA: Japan
N. muthnatae T.F.A.—rare—ASIA: Malaysia (Muthnate I.)
N. myriotricha A. Br. ex Kütz.—rare—AUSTRALIA
N. obtusa T.F.A.—rare—N. AMERICA: Canada (Que.)
N. occidentalis T.F.A.—occ.—N. AMERICA: western U.S.A. (Calif.)
N. ogivalis J. Gr. & Steph.—rare—AFRICA: Madagascar
N. oligogyra Morioka—rare—ASIA: Japan
N. oligospira A. Br.—occ.—AFRICA; ASIA; AUSTRALIA; N. AMERICA: southern U.S.A., West Indies; S. AMERICA
N. opaca (Ag. ex Bruz.) Ag.—comm.—EUROPE; AFRICA: north; ASIA; N. AMERICA; S. AMERICA
N. orientalis T.F.A.—occ.—ASIA: Japan; AUSTRALIA: Queensland
?*N. ornithopoda* A. Br. in Leonh.—occ.—EUROPE: France, Spain, Portugal
N. partita Nordst.—rare—AUSTRALIA: Queensland
N. patula J. Gr. & G.O.A.—rare—ASIA: India
N. paucicostata T.F.A.—rare—ASIA: Japan
N. penicillata A. Br.—rare—AUSTRALIA: Tasmania
N. phauloteles J. Gr.—rare—AUSTRALIA: Queensland
N. plumosa A. Br.—rare—AFRICA: Cape
N. polycarpa Pal—rare—ASIA: Burma
N. polycephala (A. Br.) Kütz.—rare—AUSTRALIA: Queensland
N. polygyra A. Br. ex Kütz.—rare—AUSTRALIA
N. praeclara J. Gr. & Steph.—rare—AFRICA: Cape
N. praelonga A. Br.—occ.—N. AMERICA: southern U.S.A.
N. pseudoflabellata A. Br. in Nordst.—occ.—ASIA: India, Malaysia, China, Japan; AUSTRALIA: New Zealand, New Caledonia
N. pseudotenuissima Kundu—rare—ASIA: India
N. pulchella T.F.A.—rare—ASIA: Japan
N. pusilla Imah.—rare—ASIA: Japan
N. pygmaea A. Br.—rare—N. AMERICA: Mexico
N. remota A. Br.—rare—AUSTRALIA: Victoria
N. rigida T.F.A.—rare—ASIA: Japan
N. robertsonii A. Br.—rare—AUSTRALIA: Victoria
N. robusta Imah.—rare—ASIA: Japan
N. saitoiana T.F.A.—rare—ASIA: Japan
N. sejuncta Imah.—rare—ASIA: Japan

N. shinii Imah.—rare—ASIA: Japan
N. sonderi A. Br.—rare—AUSTRALIA
N. *spanioclema* J. Gr. & B.-W.—rare—EUROPE: Ireland; N. AMERICA: U.S.A.
N. sphaerocephala J. Gr.—rare—AFRICA: Madagascar
N. spiciformis Morioka—rare—ASIA: Japan
N. spinosa Imah.—rare—ASIA: Japan
N. stabilis Imah.—rare—ASIA: Japan
?*N. stellaris* T.F.A.—rare—N. AMERICA: U.S.A. (Okla.)
N. stricta Imah.—rare—ASIA: Japan
N. struthioptila J. Gr. & Steph.—rare—AFRICA: Cape
N. stuartii A. Br.—occ.—ASIA: Japan; AUSTRALIA: Tasmania, New Zealand (N. Island)
?*N. sublucens* T.F.A.—occ.—ASIA: Japan, Formosa
?*N. subspicata* T.F.A.—rare—N. AMERICA: U.S.A. (Mo.)
N. subtilissima A. Br.—rare—AUSTRALIA: Swan River
N. sumatrana F.—rare—ASIA: Malaysia (Sumatra)
N. superba Pal—rare—ASIA: India
N. syncarpa (Thuil.) Chev.—occ.—EUROPE; ASIA: west
N. tanakiana T.F.A.—rare—ASIA: Japan
N. tasmanica F. Müll. ex A. Br.—occ.—AUSTRALIA: Tasmania, Queensland, New South Wales
N. tenuissima (Desv.) Kütz.—comm.—EUROPE; AFRICA; ASIA; N. AMERICA
?*N. transilis* T.F.A.—occ.—N. AMERICA: eastern U.S.A.
N. translucens (Pers.) Ag.—occ.—EUROPE; AFRICA: north
N. tricellularis (Nordst.) Nordst. in T.F.A.—rare—AUSTRALIA: New Zealand
N. tuberculata Kundu—rare—ASIA: India (Bengal)
N. tumida Nordst.—rare—AUSTRALIA: south
N. tumulosa Zanev.—rare—ASIA: Malaysia (Java)
N. tuyamae Imah.—rare—ASIA: Japan
N. uruguayensis H. af R.—rare—S. AMERICA: Uruguay
N. vermiculata J. Gr.—rare—AFRICA: Madagascar
N. wattii J. Gr.—rare—ASIA: India (Gangetic Plain)
N. zeyheri A. Br. ex Kütz.—rare—AFRICA: Cape
Nitellopsis aculeolata S.-R.—rare—EUROPE: France
N. obtusa (Desv. in Lois.) J. Gr.—occ.—EUROPE; ASIA: India; [?] N. AMERICA: Guadalupe
N. sarcularis Zanev.—rare—ASIA: Malaysia
Protochara australis Wom. & Oph.—rare—AUSTRALIA: west
P. inflata (F. & G.O.A. ex F.) Wom. & Oph.—rare—AUSTRALIA: west
Tolypella apiculata A. Br.—rare—S. AMERICA: Chile
T. californica A. Br.—occ.—N. AMERICA: west coast U.S.A.
T. comosa T.F.A.—occ.—N. AMERICA: eastern U.S.A. (N.Y.)
?*T coutinhoi* G. da C.—rare—EUROPE: Portugal
?*T. fimbriata* T.F.A.—occ.—N. AMERICA: eastern U.S.A. (N.Y.)
?*T. giennensis* Prósp.—rare—EUROPE: Spain
T. glomerata (Desv. in Lois.) Leonh.—comm.—EUROPE; AFRICA: north; ASIA: Malaysia; [?]AUSTRALIA; N. AMERICA

?*T. gracilis* Imah.—rare—ASIA: Japan
T. hispanica Nordst. ex T.F.A.—occ.—EUROPE; AFRICA: northern; ASIA: Iran, India; N. AMERICA
T. intertexta T.F.A.—occ.—N. AMERICA: northeastern U.S.A.
T. intricata (Trent. ex Roth) Leonh.—comm.—EUROPE; AFRICA; N. AMERICA
T. longicoma A. Br.—occ.—N. AMERICA: central U.S.A.
T. nidifica (O. Müll.) Leonh.—occ.—EUROPE; ANTARCTICA: Kerguelen[?]
?*T. palhinhae* G. da C.—rare—EUROPE: Portugal
T. prolifera (Ziz. ex A. Br.) Leonh.—comm.—EUROPE; AFRICA: Algeria; ASIA: India, China; N. AMERICA: U.S.A., Canada; S. AMERICA
T. stipitata T.F.A.—rare—N. AMERICA: U.S.A. (Col.?)

Characeae occur quite uniformly throughout the world in fresh and brackish water. They are absent from polar regions and from certain isolated islands. The number of species recognized for the world at present is 314. It is interesting to note that the number of species in the flora of a continent corresponds well with the area of the land mass; Asia is large with 128 species while Europe is small with 68 species. The number of continental endemic species, of which there are 251 for the world, also corresponds to the area. Europe has 27, while Asia has 81. The per cent of species endemic for a continental flora does not follow this pattern, however; Australia, Asia, and North America having high values while Europe, Africa, and especially South America having low values.

In contrast to Characeae in general, the different genera are not uniformly distributed. The number of genera present in the continental floras

TABLE 1. *General pattern of distribution of Characeae as indicated by the number of species known from the individual continents.* (T = total number of species; E = number of endemic species.

Continent	Number of species			Species of individual genera													
				Chara		*Lamprothamnium*		*Lychnothamnus*		*Nitella*		*Nitellopsis*		*Protochara*		*Tolypella*	
	T	E	%E	T	E	T	E	T	E	T	E	T	E	T	E	T	E
Europe	68	27	40	37	17	4	3	1	–	16	3	2	1	–	–	8	3
Africa	87	42	48	40	16	1	–	–	–	42	26	–	–	–	–	4	–
Asia	128	81	63	43	24	–	–	1	–	78	55	2	1	–	–	4	1
Australia	56	35	63	16	5	1	1	–	–	36	27	–	–	2	2	1	–
North America	92	56	61	40	25	–	–	–	–	42	25	–	–	–	–	10	6
South America	30	10	33	12	4	–	–	–	–	16	5	–	–	–	–	2	1

Total number of species for world 314
Total number of continental endemic species 251

range from six in Europe, five in both Asia and Australia, four in Africa, to only three in North and South America. *Chara* and *Nitella* and possibly *Tolypella* are cosmopolitan, while the small genera are quite restricted—*Lamprothamnium* to three continents, *Nitellopsis* and *Lychnothamnus* to two, and the doubtful *Protochara* to one. *Lamprothamnium* is the only genus with a primary distribution problem, species of the genus occurring in Europe-Africa on the one hand and in Australia on the other. The relative proportions of species of the major genera in the continents vary considerably. The number of species of *Nitella* to *Chara* for the continents are: Europe (16/37) which is low for *Nitella;* North America (42/40), South America (16/12), and Africa (42/40) show about equal number of each genus; while Australia (36/16) and Asia (78/43) show a high proportion of *Nitella.*

A general classification of the more conspicuously regional but not endemic species is presented below:

A. Cosmopolitan species (of all major continents)[3,4]

Chara braunii	*Nitella gracillis*
C. contraria	*N. hyalina*
C. globularis	
C. vulgaris	*Tolypella glomerata*(?)

B. North hemispheric, circumboreal (of all boreal and some austral continents)

Chara aspera	*Nitella gracilis*
C. delicatula	*N. flexilis*
C. canescens	*N. mucronata*
C. papillosa[5]	*N. tenuissima*
	N. capillaris[5]

C. South hemispheric (of all austral and some boreal continents)

Chara zeylanica
C. gymnopitys
C. hydropitys
C. succincta
C. fibrosa[5]

DEPARTMENT OF BOTANY, UNIVERSITY OF RHODE ISLAND,
KINGSTON, RHODE ISLAND
DEPARTMENT OF BOTANY, UNIVERSITY OF KANAZAWA,
KANAZAWA, JAPAN

Literature Cited

Allen, G. O. 1951. Notes on Charophyta from British Columbia. Proc Linn. Soc. (London). **162**(2): 148–152.

————. 1954. An annotated key to the Nitelleae of North America. Bull. Torrey Club **81**(1): 35–60.

Braun, A. 1867. Die Characeen Afrika's. Monatsber. K. Akad. Wiss. Berlin (1867): 782–800, 873–944. 1868.

[3] Corillion (1957: 423) includes *Nitella opaca,* but as far as is known to the present writer that species has not been recorded from Australia.

[4] Zaneveld (1940: 11) lists *Tolypella glomerata* as cosmopolitan, but its occurrence in Australia is not as yet confirmed.

[5] Uncertainties in identification or classification.

Braun, A., & Nordstedt, C. F. O. 1882. Fragmente einer Monographie der Characeen. Abh. K. Akad. Wiss. Berlin (1882): 1–211. 1883.

Corillion, R. 1957. Les Charophycées de France et d'Europe Occidentale. Travaux Lab. Bot., Fac. Sci. d'Angers. Fasc. 11, 12.

Daily, Fay Kenoyer, 1944. The Characeae of Nebraska. Butler Univ. Bot. St. **6**: 149–171.

————. 1945. The Characeae of Indiana—a preliminary report. Butler Univ. Bot. St. **7**: 124–131.

————. 1949. *Chara Kieneri*, a new species from Nebraska. Butler Univ. Bot. St. **9**: 127–130.

————. 1950. *Nitella spanioclema* Groves & Bullock-Webster var. *nidifica*, nov. var., from Alabama. Butler Univ. Bot. St. **9**: 270–272.

————. 1953. The Characeae of Indiana. Butler Univ. Bot. St. **11**: 5–49.

————. 1956. The Characeae of Nebraska—additions and changes. Butler Univ. Bot. St. **13**: 36–46.

Gollerbach, M. M. 1950. (Systematic list of the Characeae found within Russia to 1935). Plantae Cryptogamae, ser. 2(5): 20–94. (In Russian.)

Groves, H., & Groves, J. 1911. Characeae. *In* Ignaz Urban, Symbolae Antillanae, seu Fundamenta Florae Indiae Occidentalis 7(1): 30–44. Berolini.

————. 1912. Characeae from the Philippine Islands. Philippine Jour. Sci. C. 7(2): 69–70.

Groves, J. 1921. Charophyta from Annam and Guam. Philippine Jour. Sci. **19**: 663–664.

Groves, J., & Allen, G. O. 1927. On some Indian Charophyta. Jour. Bot. **65**: 335–339.

————. 1935. A review of the Queensland Charophyta. Proc. Roy. Soc. Queensland **46**: 34–59.

Groves, J., & Bullock-Webster, G. R. 1920. British Charophyta. I. London.

————. 1924. British Charophyta. II. London.

Groves, J., & Stephens, Edith L. 1926. New and noteworthy South African Charophyta. I. Trans. Roy. Soc. So. Africa **13**: 145–158.

————. 1933. New and noteworthy South African Charophyta. II. Trans. Roy. Soc. So. Africa **21**: 271–289.

Horn af Rantzien, H. 1950a. Charophyta reported from Latin America. Ark. f. Bot., ser. 2, **1**(8): 355–411.

————. 1950b. Studies in the series Pleuricellulatae of Nitella with special reference to the American Species. Medd. Göteborgs Bot. Trädgård **18**(1948): 200–211. 1950.

Imahori, K. 1951. Studies on the Charophyta in Formosa (I). Sci. Rept. Kanazawa Univ. **1**(2): 201–221 (reprinted and repaged 1–21).

————. 1954. Ecology, phytogeography, and taxonomy of the Japanese Charophyta. (Kanazawa University, Kanazawa, Japan) 234 pp.

————. 1955. Phytogeographical survey on Charophyta-flora. Sci. Rept. Kanazawa Univ. **3**(1): 93–99.

Migula, W. 1890–1897. Die Characeen. *In* L. Rabenhorst, Kryptogamengen-Flora von Deutschland, Oesterreich und der Schweiz., vol. **5**: 1–765.

————. 1904. Characeae Rossicae. Act. Hort. Petrop. **23**(3): 535–539.

————. 1930. Ueber einige japanische Characeen. Hedwigia **70**: 211–215.

Olsen, S. 1944. Danish Charophyta, chorological, ecological, and biological investigations Kongel. Danske Vidensk. Selskab., Biol. Skrifter **3**: 1–240.

Wood, R. D. 1948. A review of the genus Nitella (Characeae) of North America. Farlowia **3**: 331–398.

————. 1952. The Characeae, 1951. Bot. Rev. **18**(5): 317–353.

————. 1957. Hand-sorted punched cards in taxonomic research. Brittonia **9**(2): 65–69.

————. 1959. Gametangial constants of extant Charophyta for use in micropaleobotany. Jour. Paleobot. **33**: 186–194.

Zaneveld, J. S. 1940. The Charophyta of Malaysia and adjacent countries. Blumea **4**: 1–224.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 86, NO. 3, PP. 184–189 MAY, 1959

THE CHLOROPHYLL CONTENT OF TEA

FREDERICK T. WOLF

Marked differences in color exist among commercial samples of black, oolong and green teas. These color differences suggested to the writer the probability of significant differences in chlorophyll content. A search of available literature disclosed remarkably little information concerning the chlorophyll content of tea. Sreerangachar (1943) reported that during the fermentation of tea, tannins are oxidized to *o*-quinones, which in turn react with chlorophyll, giving rise to "tea tannin" and chlorophyll oxidation products. Tamaki (1951) patented a procedure for the extraction of chlorophyll from tea with organic solvents, followed by concentration *in vacuo*, which was claimed to recover chlorophyll in a yield of 2.7 per cent of the weight of the original tea sample. Cheney (1958) reported to the writer that he knew of no specific studies of the content of chlorophylls *a* and *b* in different teas.

Accordingly, studies were undertaken to determine the chlorophyll content of some 75 samples of tea. Many of these were obtained from retail commercial sources, and are designated in the tables only by number. Other samples were contributed through the kindness of Mr. George F. Mitchell, Hewlett, Long Island, to whom the writer wishes to express his sincere appreciation.

Methods. Chlorophyll analyses were performed according to *Official Methods of Analysis* of the Association of Official Agricultural Chemists (1950). Details of the method used were as follows: Five gm. samples of black or oolong teas, or 2.5 gm. samples of green teas were first ground to a powder using a mortar and pestle. A small quantity of $CaCO_3$ was added, and the leaf tissue was extracted in 85 per cent aqueous acetone using a Waring blendor. Prolonged extraction periods were found necessary in the case of the green teas. Following suction filtration, additional chlorophyll was extracted from the samples by washing with a small volume of ethyl ether. The acetone-ether extract was made up with additional 85 per cent aqueous acetone to a volume of 200 ml., and a 25 ml, aliquot of this solution was mixed in a separatory funnel with 50 ml. of ether. The pigments were transferred to the ether layer upon the addition of distilled water. The ether solution was then washed repeatedly with water, resulting in the removal of tannins, was made up to a volume of 100 ml., and was then dried by the addition of anhydrous Na_2SO_4.

Determinations of the optical density of the ether solution were made with a Beckman model DU spectrophotometer. Readings of each sample were

taken at 6425 A and at 6600 A, corresponding to maxima in the absorption curves of chlorophylls *b* and *a* respectively. Concentrations of chlorophylls *a* and *b* in mg./ml. were computed from the equations:

$$\text{Ch } a = 9.93 \log \frac{I_o}{I}_{(6600)} - 0.777 \log \frac{I_o}{I}_{(6425)}$$

$$\text{Ch } b = 17.6 \log \frac{I_o}{I}_{(6425)} - 2.81 \log \frac{I_o}{I}_{(6600)}$$

All data are reported on the basis of mg./gm. air dry weight. These values were obtained by multiplying by 0.16 or 0.32 the figures obtained in the above equations, in the case of 5.0 gm. and 2.5 gm. samples respectively.

Results. The results of chlorophyll analyses performed on 75 samples of tea, of which 16 were samples of green teas, 6 were oolongs, and 53 were black teas, are presented in Tables 1–3. Among the green teas studied, there

TABLE 1. *The chlorophyll content of various green teas.*

	Chlor. *a* mg./gm.	Chlor. *b* mg./gm.	Total chlorophylls—mg./gm.	Chlor. *a* per cent
Ceremonial Tea Powder (Japan)	2.28	0.96	3.24	70.4
Gyo Kuro (Japan)	1.75	0.92	2.66	65.6
Young Hyson (China)	1.20	0.25	1.44	83.0
1	1.05	0.34	1.39	75.5
2	1.07	0.23	1.30	82.7
Green Pan Fired Japan	1.12	0.16	1.28	87.9
3	0.93	0.32	1.25	74.2
4	0.95	0.29	1.23	76.6
5	1.03	0.18	1.21	85.1
6 (Japan)	0.98	0.22	1.20	81.4
Young Hyson	0.95	0.16	1.11	85.4
Basket Fired	0.93	0.15	1.09	85.9
Pinhead Gunpowder	0.94	0.12	1.06	88.3
Japan Pan-Fired Green	0.82	0.16	0.98	84.1
Uncolored Basket Fired Japan	0.84	0.13	0.97	86 6
Young Hyson	0.72	0.13	0.85	84.7
Average	1.10	0.30	1.39	81.1 ± 5.4

was approximately a four fold variation in the quantities of total chlorophylls found, ranging from a minimum of 0.85 mg./gm. in one of the samples of Young Hyson to a maximum of 3.24 mg./gm. in a Japanese ceremonial tea powder. The average total chlorophyll content of all green teas was 1.39 mg./gm. It should be noted that the chlorophyll content of Japanese ceremonial tea powder and Gyo Kuro tea is much higher than that of any other teas studied, and the average figure would be considerably lower had these two teas not been included among the samples examined.

Another finding that emerges from chlorophyll analyses of green teas is the rather high proportion of chlorophyll *a* in the total chlorophyll. While in most plants the chlorophyll *a* content may range from 67 to 78 per cent of the total chlorophyll, 11 of the 16 green teas studied were found to contain over 80 per cent chlorophyll *a*, and the average figure for all of the green teas studied was 81.1 per cent.

Six samples of oolong or semi-fermented teas were examined (Table 2),

TABLE 2. *The chlorophyll content of various oolong teas.*

	Chlor. *a* mg./gm.	Chlor. *b* mg./gm.	Total chlorophylls— mg./gm.	Chlor. *a* per cent
Jasmine	0.95	0.22	1.17	81.2
Formosa Oolong	0.88	0.24	1.12	78.9
Formosa Oolong	0.68	0.19	0.87	78.4
Formosa Oolong	0.57	0.19	0.76	75.5
Jasmine	0.46	0.10	0.57	81.9
Formosa Oolong	0.30	0.10	0.40	75.1
Average	0.64	0.17	0.82	78.5 ± 2.2

comprising only two types, but produced by several different companies. While the number of samples is perhaps too small for extensive generalization, only a three-fold variation in the quantities of total chlorophyll was found, the average chlorophyll content being 0.82 mg./gm. This is significantly less than the average of either green or black teas. While the range of chlorophyll contents of the oolong teas overlaps completely with that of the black teas, the oolong teas have a chlorophyll content generally less than that of many of the green teas.

The percentage of chlorophyll *a* in the oolong teas studied ranged from 75.1 to 81.9 per cent, and averaged 78.5 per cent. Thus, the percentage of chlorophyll *a* in oolong teas is clearly intermediate between that of green and black teas.

Fifty-three samples of black teas were examined (Table 3), the vast majority of which were commercial blends. The total chlorophyll content ranged from a minimum of 0.41 mg./gm. to a maximum of 1.75 mg./gm., and averaged 1.01 mg./gm. The range of total chlorophyll contents thus overlaps entirely that of the oolong teas, and partially that of the green teas. Two samples of green teas had a total chlorophyll content higher than that of any black tea examined, and the average chlorophyll content of the green teas studied is considerably higher than that of black teas. The chlorophyll *a* content of the black teas ranged from 63.5 to 80.4 per cent and averaged 70.9 per cent, lower than the averages of either oolong or green teas.

TABLE 3. *The chlorophyll content of various black teas.*

	Chlor. *a* mg./gm.	Chlor. *b* mg./gm.	Total chlorophylls—mg./gm.	Chlor. *a* per cent
7 (Formosa)	1.13	0.62	1.75	64.6
8 (Thailand)	1.18	0.33	1.51	78.3
9	0.95	0.47	1.42	66.9
10	0.91	0.45	1.36	66.7
African Orthodox Manufacture (Nyasaland)	0.87	0.42	1.29	67.3
11	0.84	0.43	1.27	66.4
Non-wither (India)	0.81	0.42	1.23	66.2
12	0.83	0.39	1.22	68.0
English Breakfast	0.84	0.38	1.21	69.1
C. T. C. Manufacture (Assam)	0.80	0.40	1.20	66.6
13	0.82	0.38	1.20	68.1
14	0.79	0.39	1.17	67.2
15 (Viet Nam)	0.74	0.42	1.15	63.5
16 (Japan)	0.83	0.32	1.15	72.3
17	0.77	0.35	1.12	68.6
18	0.74	0.37	1.12	66.6
19	0.75	0.37	1.12	68.0
Lapsang Souchong	0.85	0.25	1.10	77.7
20 (Ceylon)	0.79	0.31	1.09	72.0
21	0.88	0.22	1.09	80.2
Non-wither (Nyasaland)	0.69	0.39	1.08	63.9
22	0.73	0.35	1.08	67.6
23	0.78	0.29	1.07	72.6
24	0.75	0.31	1.07	70.7
25	0.74	0.32	1.06	69.9
26	0.69	0.35	1.04	66.6
27	0.74	0.28	1.02	72.3
28	0.71	0.31	1.02	69.3
29	0.73	0.29	1.01	71.7
30 (Argentina)	0.71	0.30	1.01	70.2
31	0.71	0.29	1.00	71.3
Darjeeling	0.67	0.27	0.94	71.1
32	0.76	0.18	0.94	80.4
33 (Ceylon)	0.64	0.30	0.94	68.0
34	0.65	0.29	0.94	69.0
Darjeeling	0.68	0.23	0.90	75.1
35	0.67	0.23	0.90	74.3
Darjeeling	0.66	0.23	0.89	74.4
36	0.67	0.22	0.88	75.5
37	0.66	0.19	0.85	77.7
38 (Ceylon)	0.58	0.27	0.85	68.3
39	0.56	0.23	0.79	70.5
Lapsang Souchong	0.58	0.21	0.79	73.7
40 (Assam)	0.56	0.19	0.75	74.5
41	0.54	0.19	0.73	74.3
Earl Gray	0.53	0.19	0.71	73.9
English Breakfast	0.52	0.19	0.71	72.8
42	0.53	0.17	0.71	75.7
English Breakfast	0.48	0.18	0.66	72.6
43 (Assam)	0.43	0.17	0.60	71.2
44 (India)	0.43	0.17	0.60	71.7
Lapsang Souchong	0.43	0.16	0.59	73.5
Average	0.71	0.30	1.01	70.9
Darjeeling	0.29	0.12	0.41	71.2 ±3.3

Discussion. Since tea is generally grown from seed, rather than being propagated vegetatively as clones (Mitchell 1954), and since the tea plant is grown in many parts of the world under variable soil and climatic conditions, considerable variation in chlorophyll content might be anticipated. On the other hand, the fact that a given plucking of leaf may be so processed as to result in green, oolong, or black tea, suggests the importance of the method of preparation in modifying the chlorophyll content of the fresh leaf. Unfortunately, fresh tea leaves have not been available for the analyses which might provide a convenient base line for interpretation of the data secured on the processed leaf.*

On the whole, the present data seem to provide little indication of extensive chlorophyll destruction accompanying the fermentation of black tea, during which the leaf changes from green to brown in color, since the black teas differ from the green teas with respect to total chlorophyll concentration by only 37 per cent.

Surprisingly enough, the proportion of chlorophyll *a* in black teas more closely approximates that in the majority of higher plants than does the proportion of chlorophyll *a* in either oolong or green teas. In the present study, average figures of 70.9, 78.5 and 81.1 per cent were obtained for the chlorophyll *a* content of black, oolong, and green teas respectively. This would suggest that, in the manufacture of oolong and green teas, a preferential destruction of chlorophyll *b* has occurred. Inasmuch as chlorophyll *a* is generally considered to be more labile than chlorophyll *b* (Wolf 1956), further studies are indicated in order to determine whether this interpretation is the correct one.

SUMMARY

1. The chlorophyll *a* and chlorophyll *b* content of 75 samples of green, oolong and black tea have been determined by a spectrophotometric method.

2. The average total chlorophyll content of the green teas examined was 1.39 mg./gm. Comparable figures for oolong and black teas were 0.82 mg./gm. and 1.01 mg./gm. respectively.

3. The percentage of chlorophyll *a* averaged 81.1 per cent in green teas, 78.5 per cent in oolong teas and 70.9 per cent in black teas.

DEPARTMENT OF BIOLOGY, VANDERBILT UNIVERSITY,
NASHVILLE, TENNESSEE

* An analysis of the chlorophyll content of a sample of fresh tea leaves obtained from Florida gave the value of 65.4 per cent chlorophyll *a*.

Literature Cited

Association of Official Agricutural Chemists. 1950. Official Methods of Analysis. 7th ed. 112–115.

Cheney, R. H. 1958. Personal communication.

Mitchell, G. F. 1954. Tea. Encyclopedia of Chemical Technology, **13**: 656–666.

Sreerangachar, H. B. 1943. Degradation of chlorophyll during tea fermentation. Current Sci. **12**: 205–206.

Takami, T. 1951. Extraction of chlorophyll. Japanese Patent 178,527. (Chem. Absts. **45**: 9776, 1951).

Wolf, F. T. 1956. Changes in chlorophylls *a* and *b* in autumn leaves. Am. Jour. Bot. **43**: 714–718.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 86, No. 3, pp. 190–198 MAY, 1959

ALFAROA AND ENGELHARDTIA IN THE NEW WORLD

WAYNE E. MANNING[1]

The genera *Alfaroa* and *Engelhardtia*[2] are the most primitive ones of the Juglandaceae. Any information concerning the separation of the species and their distribution is of interest.

In 1949 the writer discussed and illustrated the inflorescence, flower and fruit structure of *Alfaroa,* and gave a table of comparison of vegetative and reproductive features of *Alfaroa, Engelhardtia* (the two American species and two of the Asiatic species), *Juglans* and *Pterocarya;* he also gave detailed information concerning the distribution of *A. costaricensis* and its variety *elongata.*

Since that time considerable information has accumulated concerning the number of species and their distribution; furthermore a careful examination of specimens representing *Engelhardtia guatemalensis* indicates that two or possibly three or four species may be involved, a condition suggested earlier by Standley and Steyermark (1952). A new species of *Alfaroa* from Honduras has very recently been discovered, and is described here by Dr. Louis O. Williams.

Until 1927 only one species of this part of the family, *Engelhardtia pterocarpa,* had been described, this from Costa Rica. Now three species of *Engelhardtia* have been described, all members of the American section *Oreamunoa,* and three species and one variety of *Alfaroa,* and together their ranges as recorded in herbaria extend from the mountains of east central Mexico near Vera Cruz to Colombia in South America. This last location has not been previously reported in literature. The descriptions and notes on the distribution of these interesting trees are scattered through various books and periodicals, and it seems wise to bring together the essential facts.

Both *Alfaroa* and the American species of *Engelhardtia* have most of the pinnately compound leaves opposite, rarely on individual twigs alternate or whorled; the leaflets, slightly to strongly lepidote beneath, are mostly entire on mature trees, though on younger trees they may be strongly serrate or dentate; the terminal leaflet is lacking; the leaves are usually red when young; the pith is solid, and the densely lepidote buds are apparently naked; the flowers are in catkins or spikes, these commonly arranged in androgynous panicles; the fruits lack a true husk and are falsely 8-celled

[1] I wish to thank the curators of the herbaria who were so kind as to lend me their collections.

[2] According to Dilmy, Rimba Indonesia IV (1–2), 1955, 29–37, the original spelling of the name *Engelhardia,* based on E. Engelhard, should be used in place of the later and current spelling *Engelhardtia.*

in the middle. The fruits of *Engelhardtia* are prominently 3-winged; those of *Alfaroa* are wingless, the body of the fruit ("nut") being much larger than in *Engelhardtia,* and resembling a small walnut; there seems to be no vegetative distinction between the two genera.

The trees are frequently sterile, and the specimens therefore difficult to name. Three definite species of *Alfaroa* and two of *Engelhardtia,* these with distinctive fruits, have been described (including *A. hondurensis* described in this paper)—*Alfaroa costaricensis* Standley, *A. manningii,* Leon, *A. hondurensis* L. Williams, *Engelhardtia pterocarpa* (Oersted) Standley, *E. mexicana* Standley. In addition to these, two other taxa lacking fruit have been described—*A. costaricensis* var. *elongata* Manning, *E. guatemalensis* Standley; possibly one other sterile taxon is represented in herbaria. Whether these taxa lacking fruit represent different species or represent variations, such as from younger trees or from sterile branches of a fruiting tree, of one of the fruiting species, is uncertain. The writer is here attempting to give a key to taxa based on vegetative characters to help students who find members of the group. It is difficult to choose reliable distinguishing features, perhaps impossible. For example, on very young trees (stump sprouts?) of *Alfaroa costaricensis* the twigs and rachises are villous, the leaflets strongly acuminate, serrate, numerous, whereas on older trees the twigs and rachises are glabrous or slightly pubescent, the leaflets barely acute or even obtuse, entire, and fewer in number. With this amount of variation present it is possible that *Engelhardtia guatemalensis* and *A. costaricensis* var. *elongata,* neither of which have been collected in fruit, may represent some other species or even genus; furthermore, different appearing leaves may also merely be variations of one species. It is obvious from the discussion above and that under the taxa below, that the identifications given for many of the sterile specimens are quite uncertain.

The writer has chosen as criteria for the separation of the taxa, length of petiole, length of petiolule, number of leaflets, glandular scaliness of leaflets (leaflets lepidote) because, despite all of the variation mentioned above in *Alfaroa costaricensis,* these features remained fairly constant. On the other hand the variation in the length of the petiolule within *Engelhardtia mexicana* discussed under that species and mentioned in the key, should be noted. Only future study of abundant material, preferably in the field, of all ages of trees of each species with fruiting condition present to substantiate the identification of the plant, showing all of the variation possible within the species, will tell whether the features used in the key are reliable. At least the key will indicate the appearance of the seven (or eight) entities as seen by the writer.

The preliminary key given below, based as far as possible on fruiting specimens, is planned to be helpful, and is as accurate as the writer can make it with the material available; it is, however, possible that some sterile

specimens used in the key might prove later to belong to different species. In measuring length of petiole it is important to realize that the lowest leaflets might have broken off, so scars must be looked for. In some cases the lower part of the blade of the leaflet runs down the upper surface of the petiolule, so measurements of the length of the petiolule must be made from the lower surface; when the base of the leaflet is strongly oblique it is difficult to determine the length of the petiolule. The determination of the presence or absence of a basal auricle on the leaflet requires very careful examination, as the auricle is very small, is evident only on the lower surface of the leaflet and often on only a small number of leaflets; and is frequently hidden under the rachis. Because of these features, they are easily overlooked. In the leaves of most species the midrib of the leaflet on the upper surface appears to be impressed; upon careful examination it seems that (in most cases) the midrib area is impressed, but there is a narrow central raised rib in the impressed area; in leaves of other species (or specimens) the whole midrib appears raised; there is also a variation in the different species in the prominence of the lateral veins. These features seemed at first rather reliable ones, but a study of a larger number of specimens suggests that they are either variable, depend upon the age of the leaf or depend upon the type of pressing involved in making the herbarium specimen; consequently these features must be used with caution. There is a wide variation in amount of serration of leaflets; in some specimens of some species the leaflets are strongly serrate and in other species, as far as collected leaflets are entire. The writer believes, however that this feature is extremely unreliable and has not used it. The writer realizes the unreliability of the number of leaflets, but in the specimens so far available this character is quite evident and must be mentioned.

Details of localities and in some cases names of collectors are given when not previously reported or when important; most of the specimens are deposited at Chicago Museum of Natural History (F), some at Gray Herbarium (GH), New York Botanical Garden (NY), U. S. National Herbarium (US), and at Bucknell University in the writer's personal herbarium (WEM).

KEY TO THE SIX SPECIES AND ONE VARIETY SO FAR DESCRIBED FOR ALFAROA AND ENGELHARDTIA IN THE NEW WORLD

Leaves extremely short-petioled, the petiole .5–1.5 cm. long; lower leaflets conspicuously reduced; leaflets thin, very remotely lepidote beneath, usually pubescent; fruit wingless, very hairy, not clearly ribbed, 3 cm. long (leaflets sessile, 14–18–22, narrowly oblong, without basal auricles; individual staminate flowers in well developed catkins stalked, with sepals not hooded, and with 6–10 stamens) 1. *Alfaroa costaricensis*

Leaves short- to long-petioled, the petiole 1.5–7 cm. long; lower leaflets smaller than median ones, but not conspicuously reduced; leaflets

mostly coriaceous, densely though minutely lepidote beneath, usually glabrous; fruit glabrous

Petiole 1.5–3 cm. long

Leaflets 14–18 (–22), sessile, oblong, without auricles; only staminate flowers known, these sessile, the perianth usually cup-shaped, the 4 hooded "sepals" similar

2. *costaricensis* var. *elongata*

Leaflets on young trees 10–14 (or to 18?) subsessile, on fruiting branches of older trees 6–8, with petiolules 2–3 mm. long; leaflets linear-lanceolate, some of them with small basal incurved or outwardly projecting auricles on one or both sides as viewed from lower surface of leaflet; fruit small, glabrous, winged, the wings small (body of fruit or nut 6–7 mm. long, total length of fruit 4–4.8 cm.); staminate flowers unknown

6. *Engelhardtia mexicana*

Petiole 4–7 cm. or more long

Leaflets mostly 14–16, tapering at base, with flat margins, commonly lustrous light cinnamon brown beneath becoming pale brown in older leaves, the midribs beneath medium, rather inconspicuous; lateral veins 20–25 pairs, rather straight, branching at apex, the branches rather definitely connecting with apices of adjacent side veins; petiolules 3–5 mm. long; leaves large, the leaflets large, elongate; flowers and fruit unknown

7. *Engelhardtia guatemalensis*

Leaflets 4–12, in some species with revolute margins toward the base, mostly obtuse at base though not always definitely so on leaflets with revolute margins, commonly pale brown beneath, not lustrous, the midrib beneath rather stout, very conspicuous; lateral veins 12–20 pairs; petiolules 2–10 mm. long; leaflets medium, with comparatively broad leaflets; branching of side veins various

Leaflets 4–8, strongly petiolulate (petiolule 5–10 mm. long), the margin usually recurved at base; side veins 12–15 pairs, beneath level of surface of leaflet on upper side of leaflet, curving, their apices not clearly connecting with next side veins; individual staminate flowers sessile, with sepals not hooded, and stamens 16–23; fruit large, with large wings (body of fruit or nut 1 cm. long, total length of fruit 10–12 cm.)

5. *Engelhardtia pterocarpa*

Leaflets 4–12, with comparatively short petiolules, these 2–4 mm. long; side veins 16–20 pairs, raised slightly above surface on upper side of leaflet, rather straight, branching at apex, the branches rather definitely conconnecting with apices of adjacent side veins; fruit unwinged, glabrous, 3–6 cm. long.

Leaflets mostly 4–8, not recurved at base; fruit 6 cm. long, conspicuously lenticellate, not clearly longitudinally ribbed, inconspicuously lepidote at maturity, with a rather thick wall; staminate flowers unknown

4. *Alfaroa hondurensis*

Leaflets on some of leaves 10 or more (8–12), the margin on some of leaflets recurved toward base; fruit 3 cm. long, clearly longitudinally ribbed, not lenticellate (verrucose), conspicuously lepidote, with comparatively thin wall; staminate flowers cup-shaped, with 4 equal hooded "sepals."

3. *Alfaroa manningii*

1. *Alfaroa costaricensis* Standley (Jour. Wash. Acad. Sci. 16: 78, 1927; Flora of Costa Rica, Field Mus. Publ. Bot. 18: 372, 1937; Manning, Bull. Torr. Bot. Club 76: 202, 1949; Standley & Steyermark, Flora of Guatemala, Fieldiana, Bot. 24: IV: 353, 1952). Guatemala (Depts. Huehuetenago, Suchitepequez, Quezeltenango); Costa Rica (Cartago, Turrialba region); Panama (Chiriqui-Boquete region). The exact distribution is given by Manning (1949). Some of the specimens originally called by Standley and Steyermark *Engelhardtia guatemalensis* belong here.

2. *A. costaricensis* var. *elongata* Manning (Bull. Torr. Bot. Club 76: 203, 1949). Costa Rica (Vara Blanca). The differences between this variety and the species are so great that they undoubtedly belong to two different species, but the exact position of this taxon is still uncertain; fruit is necessary. Although the plants representing this taxon might be related to some other known species of *Alfaroa* or *Engelhardtia* and the difference in appearance of the leaves might be due to differences in ages in the trees, it should be pointed out that the tree from which the type specimen *of A. costaricenses* var. *elongata* was collected was a large mature tree.

3. *A. manningii* León (Ceiba 4, no. 1, 42, 1953). Costa Rica (Turrialba); Colombia. This last collection (Dept. Santander; western slope of Mount Pena Blanca, near Charta; alt. 2500–2600 m.; dense woods; slender shrub 15–18 ft., fruit green; Killip & Smith 19285, GH, probably also will be found in cooperating institutions NY, US), with small, immature fruit (2 cm. long), is the first record of either *Alfaroa* or *Engelhardtia* from South America. The identification of the South American plant is not absolute, and the specimen might represent a new species. The leaves have about 12 leaflets, but the petiolules are shorter (.5 mm. long) than in the Costa Rican specimens (2–4 mm. long), and the leaflets seem flat, not recurved, toward the base (better pressed?). The immature fruit is clearly not lenticellate as in *A. hondurensis*, but the longitudinal ridges, such as occur in *A. Manningii*, are rather obscure.

The leaves of all specimens so far collected have entire leaflets. See also the note under *Engelhardtia pterocarpa*.

The following description and note were written by Dr. Louis O. Williams.

4. **Alfaroa hondurensis** L. Wms., no. sp. Arbor usque ad 25 met.; folia oppositia, subaequalia, usque ad 30 cm. longa; petiolo 4–4.5 cm. longo; foliolis 6–8, elipticis vel oblongo-lanceolatis, acutis vel acuminatis, ca. 11–16 cm. longis et 3.8–5 cm. latis, petiolulis 2–4 mm. longis; fructus oblongo-ovoideus, ca. 6.5 cm. longus et 2.5-cm. diametro. A large forest tree to about 25 m. tall, the wood pink. Branches with oval to elongated lenticels darker than the bark, glabrous but possibly with lepidote scales when young; ends of the branchlets and petioles sometimes showing a waxy exudate interspersed with resinous dots; young leaves covered with a resinous exudate. Leaves

opposite, pairs equal or nearly so, each up to about 30 cm. long; petiole 4–4.5 cm. long; swollen at the attachment with the twigs; rachis to about 10 cm. long, glabrous or with a wax-like exudation, becoming clean with age; leaflets 6–8, rarely the number uneven by suppression, alternate or usually opposite, elliptic to oblong-lanceolate, acute or acuminate, glabrous above, with numerous minute, obscure lepidote scales below, about 11–16 cm. long and 3.8–5 cm. broad, lower surface much lighter in color than the upper one; petiolules 2–4 mm. long, swollen at the base. Inflorescence and flowers unknown. Fruit oblong-ovoid, round to slightly flattened in cross section, not hairy, dark brown, covered with many small but conspicuous pustuliform lenticels, not longitudinally ridged or obscurely so, about 6.5 cm. long and 2.5–3 cm. in diameter; stigma persistent; endocarp wall thick and very hard, 4–5 mm. thick; ovary 8-celled at the middle.

HONDURAS: tree 80 ft. tall, wood pink; road to Mochito Mine, vicinity of El Sauce near Lake Yojoa, department of Sta. Barbara, alt. 1200 m.; September 26, 1952, *Paul H. Allen* and *Alphonse Chable* 6573. (TYPE in the U.S. National Herbarium).

The genus *Alfaroa* had previously two species, *A. costaricensis* Standl. from the mountains of Guatemala, Costa Rica, and Panama, and *A. manningii* León from Costa Rica. The second species is most closely related to the present species.

Alfaroa hondurensis is easily distinguished from *A. costaricensis* by its smaller number of broader leaflets, 6–8 instead of 10–20, its large and glabrous instead of small and pubescent fruits. *Alfaroa manningii*, with similar leaves and with glabrous fruits is much more closely related to the present species but has smaller fruits of somewhat different shape which are conspicuously longitudinally ribbed and not lenticellate. The geographic separation is rather great. There are probably no forest areas between central Costa Rica and north central Honduras which would provide the kind of habitat in which the known species of *Alfaroa* occur.

The available specimen of this species is not complete. More adequate specimens are to be desired.

As indicated by Dr. Williams in the note above, this species is similar vegetatively to *A. manningii;* the leaflets appear to average fewer in number and are apparently not recurved at base; the narrow main vein in the impressed central midrib region of the leaflet extends further toward the tip of the leaflet judging from the types observed by the writer. The fruit is very different in size and aspect. The leaflets are entire in the specimens so far collected. Leaves and fruit of the new species are illustrated in figure 1. Whether this is a good species or a variety of *A. manningii*, must be determined by future studies of more complete collections. See note under *Engelhardtia pterocarpa*.

5. *Engelhardtia pterocarpa* (Oersted) Standley (Trop. Woods 12: 15, 1927; Oersted, Vidensk. Meddel. Nat. For. Kjob. 1856: 33–43, as *Oreomunoa*

pterocarpa; Oersted, idem, 1870: 159–174; C. de Candolle, Bull. Soc. Bot. Geneve II, 6: 165–170, 1914, as *Engelhardtia Oreomunoa;* Standley, Flora of Costa Rica, Field Mus. Nat. Hist. Bot. 28: 373, 1937, as *E. pterocarpa;* Manning, Amer. Jour. Bot. 25: 407–419, 1938 as *E. pterocarpa;* Manning, item, 27: 839–852, 1940; Manning, idem, 35: 606–621, 1948. Guatemala (?);

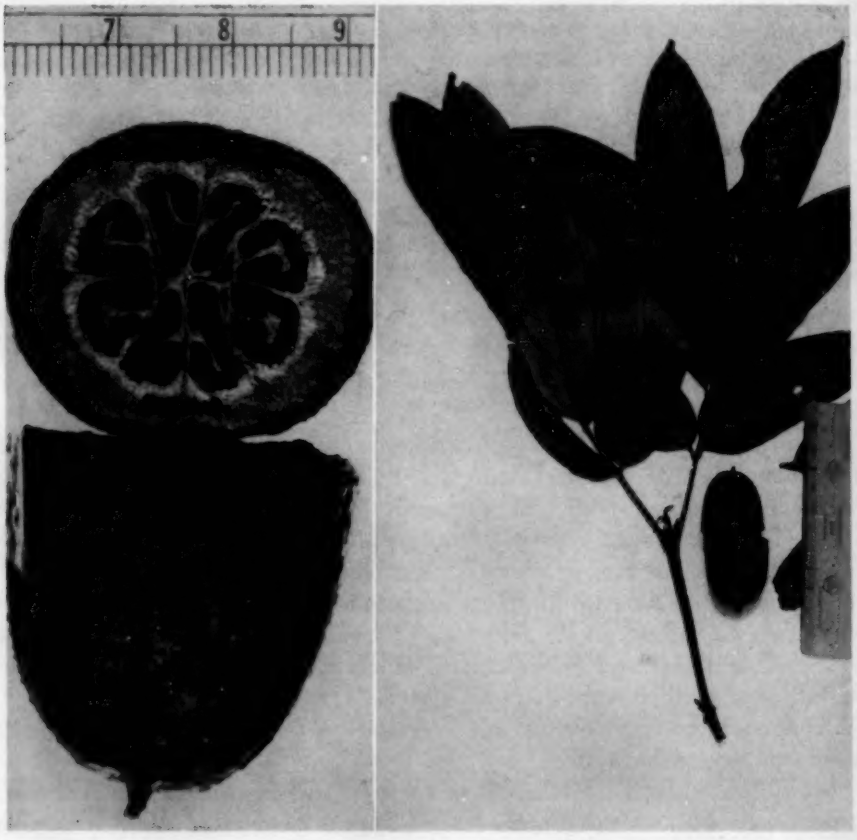


FIG. 1. *Alfaroa hondurensis* L. Williams. Leafy branchlet and fruit (approximately ½ natural size), and details of fruit (X 1½).

Costa Rica. This species has been known for over a century from only the valley of Rio Reventazon, on the Caribbean slope of Costa Rica at 200–1500 meters (between Naranjo and Tucurrique; Hacienda La Gloria, near Juan Vinas; Peralta; Cachi; Pejivalle Farm, valley of Pejivalle River, 12 miles s. of town of Turrialba; Carpenteria mountains, westward from Cartago). The record from Guatemala was originally called *E. guatemalensis* by Standley and Steyermark, but appears to match this species in several respects; it is sterile (Dept. Baja Verapaz: below Petal, alt. 1550 m.;

Standley 90967, small tree, young leaves red, GH, US, NY.). It is not completely typical, as the margins near the bases of the leaflets are flat (the leaves better pressed?) and the branching of the lateral veins is not typical; the identification is very uncertain, and this collection might prove, instead of the suggestion mentioned here, to be *Alfaroa hondurensis* or *A. manningii* or even atypical *E. guatemalensis;* the coriaceous leaflets are 6–8 (–9 or more?), rounded at base, with side veins somewhat impressed on upper surface; the petiole is 3.5 cm. long; on leaves on younger part of twig (US), the petiolules are 3–4 mm. long, on leaves on older part of (same?) twig (GH) 6–8 mm. long. The leaves of *Engelhardtia pterocarpa* have entire leaflets on all specimens so far collected. The inflorescences, the pistillate flowers and fruit, and the staminate flowers were described and illustrated by the writer in the three papers listed above.

6. *Engelhardtia mexicana* Standley (Trop. Woods 12: 15, 1927). Mexico (Vera Cruz, Oaxaca, Chiapas); Guatemala; Costa Rica Standley, in his original description of the species, noted the location in Chiapas. Miranda (1946) noted the collection of *Engelhardtia* from near Orizaba, and at that time planned to describe this as a new species because of the numerous leaflets. A. J. Sharp (*#46135* TENN) collected it from the same area, Cerro de San Cristobal, near Orizaba, Vera Cruz in 1946; the writer collected it from the same mountainside in 1953 (*Manning & Manning 53746, 53767, 53770, 54775,* WEM).

The specimens collected by the writer from Orizaba have much shorter petiolules and a larger number of leaflets (in one specimen as many as 18 leaflets) than the fruiting type of the species, and although they probably represented young conditions, they might prove to be *Alfaroa costaricensis* var. *elongata*, which they somewhat resemble, or even some other species. Many of the leaflets of the specimens from Orizaba have small but definite basal auricles much as in the type, though sometimes projecting outward conspicuously; there are a small number of elongate hairs usually present on the under side of the leaflet beneath the auricle, not on the rest of the leaflet, and the younger twigs are frequently minutely but densely puberulent; some of the leaflets of both the Orizaba and the Chiapas specimens are sharply serrate. Dr. Sharp informs me that he and Hernandez X. saw *Engelhardtia*, presumably *E. mexicana*, on top of the sierra between Rio Grande and headwaters of Rio Coatzocoalcas, in from Niltepec, Oaxaca, in 1946; this specimen has not turned up so far.

A few specimens from Guatemala (*Standley 70379*, Dept. Alta Verapas, region of Chelac, GH, F; *Steyermark 43810*, Dept. El Progresso, Sierra de las Minas, Montana Canahui, GH, F; Lamb 113, Dept. Baja Verapaz, Sierra de las Minas, east of Chilasco, F; *Steyermark 48619*, Dept. Huehuetenango, Cerro Huitz, between Mimanhuitz and Yulhuitz, F; *Aguilar 616*, Dept.

Guatemala, F), named by Steyermark and Standley *Engelhardtia guatemalensis*, might be from young trees of that species, but are very different from most specimens of that species, and match in most features specimens of the young trees of *E. mexicana* from Orizaba: the leaflets are linear-lanceolate, and auricles are present on a few of the leaflets with hairs beneath the auricles. These specimens in turn resemble specimens from Costa Rica (*Standley and Torres 50969*, El Muneco, US; *Standley 39446*, La Estrella, US) called by the writer (Manning 1949, p. 204) *Alfaroa costaricensis* var. *elongata*. Some of the specimens from Guatemala and Costa Rica have small leaves and the number of leaflets is slightly larger (up to 18 in Costa Rica). The identification is, of course, uncertain, and these could be *Alfaroa costaricensis* var. *elongata*, young trees of *Engelhardtia guatemalensis*, or an entirely different taxon.

The only fruiting specimen of *Engelhardtia mexicana* is the original collection from Chiapas, located at the Philadelphia Academy of Sciences. The fruit was illustrated by the writer in a previous article (Manning, Amer. Jour. Bot. 35: fig. 106, p. 848, 1948).

7. *Engelhardtia guatemalensis* Standley (Field Mus. Nat. Hist. Bot., Ser. 22: 12, 1940; idem: 225; Standley & Steyermark, Flora of Guatemala, Fieldiana, Botany 24; Part III: 355, 1952). Guatemala (Depts. Alta Verapaz, Guatemala, San Marcos, Quezaltenango). Some of the original collections cited by Standley and Steyermark have proven to belong to *Alfaroa costaricensis*, *Engelhardtia pterocarpa*, and *E. mexicana* as noted above; Standley and Steyermark (1952) had suggested that their material might prove to be a mixture. The descriptions of the species by Standley and Steyermark is therefore not strictly accurate, as it covers more than one species. The leaflets on all specimens so far collected of the species as understood by the writer are entire. No flowers or fruit have so far been collected, and there is, of course, a possibility that *Engelhardtia guatemalensis* might not be distinct from *Alfaroa manningii*, *A. hondurensis*, or *Engelhardtia pterocarpa*.

BOTANICAL LABORATORY, BUCKNELL UNIVERSITY
LEWISBURG, PA.

Literature Cited

Manning, W. E. 1949 .The genus *Alfaroa*. Bull. Torrey Club **76**: 196–209.

Standley, P. C. & Steyermark, J. A. 1952. *Engelhardtia guatemalensis*, in Flora of Guatemala. Fieldiana, Bot. **24**: IV: 355.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 86, No. 3, pp. 199–205 MAY, 1959

TORREYA

Note on Radial Tree Growth

CARL D. MONK

Most radial growth curves obtained by the use of the dendrometer or dendrograph are typically logistic or S-shaped. After the peak of the curve has been reached and growth has ceased, there is almost invariably a decrease. It is generally agreed that this decrease is associated with tissue dehydration in late summer and fall due to inadequate soil moisture and continued transpiration. If the curve is extended through the winter months there may be further decline. This decline is probably associated with dehydration, a process important in frost hardiness (Levitt, 1941). During winter there may also be some increase in the curve but only rarely does this exceed the fall maximum. It is generally not until the initial spring incline that the fall maximum is reached.

Brown (1915), working on histological growth studies in *Pinus strobus* L., recognized two types of growth in spring: (1) growth without cell division—usually occurring in phloem and related to water uptake or rehydration of tissue replacing that lost in fall and winter, and (2) growth by cell division—a result of cambial activity. These phenomena have been recognized by most researchers of radial tree growth. However, there is no record until 1952 of concurrent histological and dendrometer studies to determine the relationship between these two types of growth (Fraser, 1952). From these and later studies conducted in early spring Fraser (1956) concluded that "a swelling is invariably found before any wood cells have been laid down."

When the literature on radial growth is surveyed, one finds three criteria for determining the date that growth begins: (1) date of the initial increase of the curve in spring, (2) the date when the spring curve reaches the fall maximum, and (3) the date by which 5 percent of the annual increment has been reached. The first of these may include growth with and without cell division. The second criterion assumes that cells have a maximum expansion. This expansion represents the fall peak and any deviation below this peak involves dehydration and rehydration. It should be realized, however, that the fall maximum does not necessarily represent the maximum potential expansion, particularly during years of low rainfall. The third criterion is frequently used when comparisons between species are made. This enables the investigator to place each species on a common basis and thereby rid the data of differences in growth rates.

For studies concerned only with net annual increment and interspecific comparisons, there is no need to separate the dates of growth with and without cell division. On the other hand, if one is interested in determining the external factors causing the initiation of growth, it may then be necessary to separate the two phenomena. Whether the swelling due to rehydration is to be considered as growth is an academic question, but nevertheless, there may be certain temperature requirements necessary for this phenomenon to occur. Also, if the cells have been dehydrated, rehydration may be a prerequisite for cell division. Temperature requirements for cell division may differ from the temperature requirement for rehydration. In other words, growth in spring involves two distinct processes, each of which may have different requirements.

A preliminary study was conducted during the spring of 1958. Two species were chosen for histological studies (sugar maple, *Acer saccharophorum* K. Koch, and beech, *Fagus grandifolia* Ehrh.). The trees, located in Hutcheson Memorial Forest in New Jersey, used for histological sampling were not the ones used for dendrometer studies; however, they were close together, on similar sites, and of similar size. During the period of study, observable phenological events coincided in those trees from which cambial samples were taken and the dendrometer trees.

Dendrometer readings were taken weekly at the same time of day. Bark samples were taken semi-weekly. A wood chisel was used to remove a sample of about one-half

square inch. All samples were taken between 4 and 6 feet from the ground. This seemed justifiable in view of the rapidity at which the march of cambial activity occurs downward in deciduous trees (Fraser, 1956). Each sample was carried back to the laboratory immediately, and permanent slides were made that day. If the cambial zone was damaged too much a new sample was taken that day. The staining technique is included below. With this technique, permanent slides can be had 20 to 30 minutes after reaching the laboratory with the samples. This is particularly important if the samples are damaged, for enough time is left to take a new sample.

Cut on sliding microtome in 50% alcohol and place sections on microscope slide.
Fix in FAA (2 to 5 minutes).
Rinse once in 50% alcohol.
Safranin O after Johansen (1940) (2 to 6 minutes).
Rinse in 50%, 70%, 95%, and 100% alcohol.
Fast green (10 seconds) (0.5gm. fast green, 125cc xylene, 125cc methyl salicylate, and 250cc 100% alcohol).
Rinse out excess fast green with mixture of ½ methyl salicylate and ½ 100% alcohol.
Rinse in xylene.
Mount.

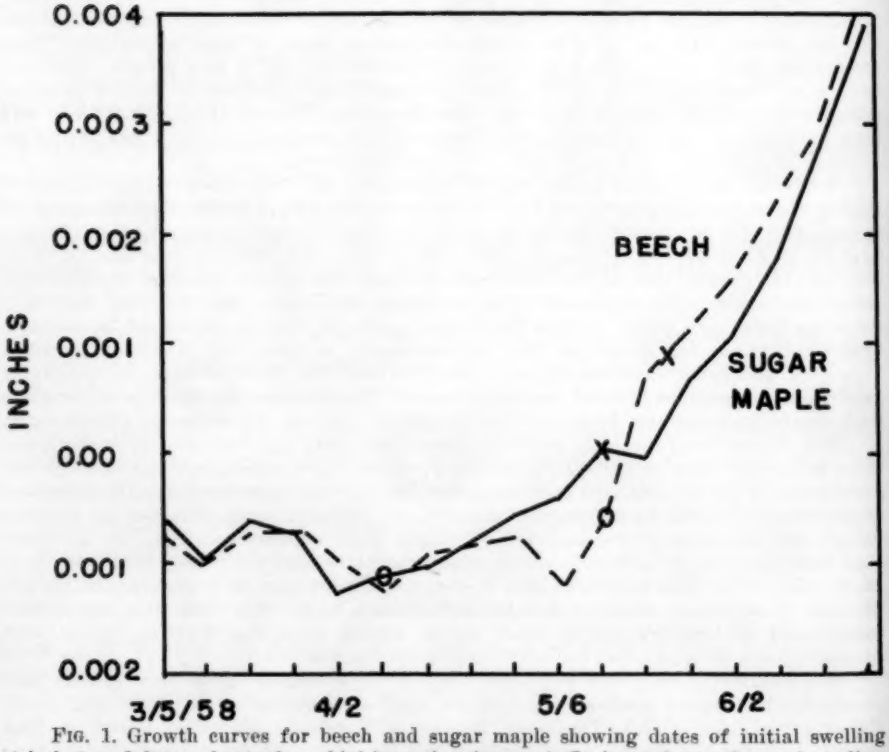


FIG. 1. Growth curves for beech and sugar maple showing dates of initial swelling (circles) and dates of actual cambial inception (crosses). Inches refer to change in radius.

All steps from fixation to mounting are easily done with the sections on the microscope slide to be used for the permanent slide.

The results of the preliminary survey are summarized in Figure 1. The time difference between the date of initial swelling and the date of cambial inception is 35 days in

sugar maple and 10 days in beech. Fraser (1956) found a difference of 14 days between initial swelling and cell division in sugar maple and 13 days in beech.

If the date of radial enlargement in sugar maple is considered with respect to the fall or winter maximum (3/19), then the date of radial increase would change from 4/9 to 4/30 (Figure 1). If 4/30 is considered the true date of radial enlargement then 14 days elapse between radial enlargement and cambial inception. This is in accord with Fraser.

These differences between date of swelling and date of actual cell division are of a large magnitude. If specific environmental conditions controlling growth initiation are being sought, the time of initial swelling and the time of cambial inception must be investigated more closely.

Department of Botany
Rutgers, The State University of New Jersey
New Brunswick, New Jersey
Present Address:
Department of Botany
University of Florida
Gainesville, Florida

Literature Cited

Brown, H. F. 1915. Growth studies in forest trees. II. *Pinus strobus*. Bot. Gaz. **59**: 197–240.

Fraser, Donald A. 1952. Initiation of cambial activity in some forest trees in Ontario. Ecology **33**: 259–273.

————. 1956. Ecological studies of forest trees at Chalk River, Ontario, Canada. II. Ecological conditions and radial increment. Ecology **37**: 777–789.

Johansen, D. A. 1940. Plant microtechnique. McGraw-Hill Book Company, Inc., N. Y.

Levitt, J. 1941. Frost killing and hardiness of plants. A critical review. Burgess Publishing Co., Minneapolis.

Supplementary Notes on Cynanchum, Elscholtzia and Other Local Plants

JOSEPH MONACHINO

A question sometimes occurs as to what happens to an adventive plant after it has been first duly recorded for a locality. Does it persist? Is it discovered elsewhere? Is there a sequel to the published report? Is anyone, besides the author, really interested? The following notes are on several weeds that were reported recently from New York.

Cynanchum medium (6). The species was reported by me from Westchester and the Bronx in New York and York County in Pennsylvania; I suggested that, although confused with *C. nigrum*, it is nearest related with *C. Vincetoxicum* (*C. officinale*). I received a letter dated July 15, 1957, from Dr. R. J. Moore, Botanst, Cytogenetics, Dept. Agr. Sci. Serv., Bot. & Plant Pathology Lab., Ottawa, Canada:

"I was interested in your recent paper 'Cynanchum in The New York Area'. A species of *Cynanchum* has been growing as an escape about the Dominion Arboretum and adjacent areas for at least the past 25 years. We have been calling it *C. nigrum*, although we are aware that it does not fit this species well.

"I am sending you a specimen and would appreciate your opinion as to whether this is the *C. medium* which you have found in your area. There is, of course, no need to return the specimen.

"I have found that the chromosome number of our plant is $2n = 22$. This count differs from the counts reported by Pardi—*C. nigrum* $2n = 44$, *C. officinale* $2n = 22$. This disagreement has strengthened our doubts regarding the identity of the plant."

The species proved to be identical with the one I had reported. Dr. Moore wrote further (July 29, 1957):

"The oldest specimen of this *Cynanchum* that we have was collected in 1899 at 'Toronto Junction' (Mrs. A. G. White—Sept. 21, 1899). This collection is probably on the

northeastern limits of Toronto. The oldest Ottawa collection was made in 1931, near the Chemistry Division, Central Experimental Farm."

Elscholtzia ciliata (8). I stated that the station in Inwood Hill Park, upper end of Manhattan Island, New York City, was the most southerly one reported. A specimen collected in West Virginia (10) at a date earlier than mine has just now passed my hands: *Mr. & Mrs. H. A. Davis 9272*, a troublesome weed on the D. W. Stemple farm near Camden-on-Gauley, Webster County, West Virginia, Sept. 8, 1950. Koeppen (2) has recorded the species for Wisconsin, roadside camping area at the north end of Devils Lake State Park, Nov. 2, 1946. I revisited the Inwood site on Nov. 29, 1958, and found *Elscholtzia* prospering and fruiting abundantly.

Elatine triandra (9). The Brooklyn station was revisited several times in 1958 and the colony was found still thriving. A specimen from the original collection had been sent to the Wiegand Herbarium at Ithaca. Robert Clausen confirms the determination.

Solidago bicolor with yellow flowers (4). The year following my description of the yellow-flowered silver-rod from Woodlawn, I found it again at Tibbets Brook Park, Westchester Co., N. Y. (*Monachino 587*, Sept. 30, 1956). The flower color of the fresh plant was a bright yellow, but faded soon after drying. Only one plant of this remarkable color-form was discovered amongst the many typical silver-rods and other species of *Solidago*.

Anthriscus sylvestris (7). The species was collected by Dr. Fritz G. Hochwald in June, 1956, Yonkers, Warburton Avenue, Hastings, service entrance to Graham School; this is not far from the Old Croton Aqueduct site of my report. Later it was brought to me for identification by Frank C. MacKeever who said he collected the plant on Quaker Ridge Rd., near Mamaroneck, Westchester Co., in a shaded spot off the auto road, where he had stopped for a hurried moment. The species in the United States is also known from Montesano, Washington (coll. J. M. Grant, 1918).

Atriplex tatarica (3). The species is excluded by Fernald; it is cited by Gleason as "occasional on ballast and waste places at Atlantic seaports." A highway now runs over the spot near Pelham Parkway where in 1949 I collected the *Atriplex tatarica* and *Inula graveolens* reported by Moldenke. These two species had been collected by Ahles (1) in the same locality the year before. In earlier collections deposited in The New York Botanical Garden *Atriplex tatarica* is represented from ballast, 8th Ave., N. Y. C., 1879 and 1880; Brooklyn, 1890; Yonkers Wool Mill, 1898; Port Morris, 1901; Arlington, Staten Island, 1909; Jersey City, 1879; Greenwich Pt., Philadelphia, Pennsylvania, 1874. Our earliest record of introduction in America is thus 1874. What appears to be the same species was recently collected far inland, at Randolph, Wisconsin, railway embankment, Aug. 22, 1958, by F. R. Irvine (*U.S. 675*). Dr. Irvine was first taken to the habitat of *U.S. 675* by Dr. R. Jewkes. The fruiting bracteoles in this collection are not matured for absolute identification. The specimen was returned to Dr. Irvine, but a fragment was retained for The New York Botanical Garden.

Dr. F. R. Irvine, who collected the *Atriplex* mentioned above, is a botanist of some distinction for his work on the African flora, but is not acquainted with American plants. In August, 1958, he made a small cursory collection of specimens (235, including duplications) from Croton-on-Hudson, New York (64 numbers), Richmond, Indiana (23 nos.), and Randolph, Wisconsin (20 nos.). These were identified by me and returned to him for transmittal to Kew; none were retained for The New York Botanical Garden, except a fragment of the *Atriplex*.

There is one other noteworthy specimen in Dr. Irvine's collection: an anomalous hickory from Croton-on-Hudson, Mrs. Winifred Courtney's graden, Westchester Co., N. Y. (*Irvine U. S. 761*). This has the typical foliage of *Carya tomentosa*, but a fruit with extraordinarily thin husk for the species. The husk is mostly less than 3 mm. thick. A leaf and fruit, removed from the same branch, were sent to Wayne E. Manning, who agreed that the leaf was of a mockernut. However, Dr. Manning stated he has never seen fruit-husk so thin in the species, and suggested that the tree might well be a hybrid between *C. tomentosa* and *C. ovalis*. That even such a small lot of specimens as the one collected by Dr. Irvine should yield two interesting items is further support of my reiterated contention—field work can still contribute to our knowledge of the Manual Range taxonomy!

Aegilops cylindrica (11). A visit to the locality in Brooklyn recorded by Svenson in 1938 failed to reveal the plant. I found it elsewhere in the borough (*Monachino 438*, June 21, 1946, waste ground at northeast corner of Ave. W & East 4th St., abundant and dominant, the only other weed being *Bromus tectorum; s.n.* June 10, 1948, same spot). It was also brought from Staten Island for my inspection by Bob Meyer, who informs me (Jan. 1959) that he collected the plant at Rosebank about five years ago but has not seen it since. The illustration erroneously named *A. cylindrica* in Gleason's New Britton and Brown was drawn entirely from a specimen collected by E. P. Bicknell at the Yonkers Wool Mill on June 26, 1898. As Stanley J. Smith pointed out, the species is *A. triuncialis*, a determination confirmed by J. R. Swallen. It is of a rarer form in which the lower spikelets have the awns greatly reduced. The Bicknell specimen is also the basis, thus in itself unwarranted, for the "around wool-mills" distribution given by Gleason.

A condensed, manual-sized, non-illustrated version of "The New Britton and Brown Illustrated Flora" is now in the process of preparation. The work has been primarily straight editorial but now contains some corrections, deletions and additions. In this manual *Cynanchum medium* is admitted, based on my 1957 report. The distributional range of *Elscholtzia ciliata* is stretched to include the Inwood station, and that of *Elatine triandra* var. *triandra*, I am informed by Arthur Cronquist (Dec. 1958), will range south to Virginia. While *Atriplex tatarica* and *Aegilops cylindrica* remain as in the present edition of the Illustrated Flora, *Aegilops crassa* is ousted, following my argument in the article "Yonkers Wool Mill Plant Records" (5), and so are several other ephemeral waifs.

Literature Cited

Ahles, H. E. 1951. Interesting weeds in New York City. Bull. Torr. Club **78**: 266–269.

Koeppen, R. C. 1958. Preliminary reports on the Flora of Wisconsin. No. 41. Labiatae-Mint Family. Trans. Wisc. Acad. Sci. Arts & Let. **46**: 140.

Moldenke, H. N. 1950. Interesting new records and range extensions. Bull. Torr. Club **77**: 45.

Monachino, J. 1955. A yellow-flowered silver-rod. Bull. Torr. Club **82**: 62–63.

———. 1956. Yonkers Wool Mill plant records. Rhodora **58**: 43–45.

———. 1957. Cynanchum in the New York Area. Bull. Torr. Club **84**: 47–48.

———. 1957. Adventive plants in New York. Rhodora **59**: 17–20.

———. 1958. Elscholtzia ciliata in New York. Bull. Torr. Club **85**: 139–140.

———. 1958. Elatine triandra in New York. Rhodora **60**: 58–59.

Strausbaugh, P. D. & Core, E. L. 1958. Flora of West Virginia (Pt. 3), p. 812.

Svenson, H. K. 1938. Aegilops cylindrica and Kyllingia pumila in the Torrey Club range. Torreya **38**: 72.

Proceedings of the Club

Report of the Chairman of the Field Committee for 1958

Joseph Monachino

The field trips conducted in 1958 were generally quite successful. It seems to the Chairman that there was a remarkable improvement in attendance over the trips held the several past years.

We were particularly delighted in the influx of young people on our walks. This tendency is much to be encouraged; we should make special efforts to attract youth.

Forty trips were conducted in 1958, from March to November. We had 26 leaders. As examples of the large attendance and the diversity of the trips, from early spring to late autumn, I might mention: Greenbrook Sanctuary, April 26, leader Bill Rissanen, 40 members of the Club and the Palisades Association; Stony Brook, Sept. 14, guest leader Guy Nearing, 12 cars and about 35 persons; Van Cortlandt Park, Nov. 23, the last field-trip of the season, leader the Chairman of the Field Committee, attendance 27. I wish to add at this point, however, that our aim should be to hold attendance to about 12 to 15; when larger, the group is unwieldy.

Many of the trips have been duly reported for Torreya. The Chairman alone has submitted for publication in Torreya 5 reports for 1958. These accounts will contribute to our published knowledge of the Local Flora. We have submitted records of interesting extensions of distributional range. Some of the notes constitute corrections in the descriptive and illustrative taxonomy of the northeastern plants.

Specimens have been collected in the course of Torrey trips. For instance, an unearthy slate-blue colored polypore, *Polyporus caeruleoporus*, was collected by Dr. C. T. Rogerson, Mycologist, on the Stony Brook trips, and is now deposited in the Herbarium of The New York Botanical Garden.

Mr. Harry Lehr is continuing to collect and report new plant records for Rockland Co.; Karl Brooks is continuing with Putnam Co.; Bill Rissanen is studying the flora, particularly the bryological flora, of Greenbrook Sanctuary; Bob Meyer is studying the Gramineae of the Local Range; Miss Elizabeth Hall has initiated a check-list account of the plants of Westchester Co.

In behalf of the Field Committee I wish to extend thanks of gratitude to the many leaders and other helpful persons that have made the field program possible. I am particularly appreciative of the help received from the last Field Chairman, Dr. Fairbrothers, who spared no time to familiarize me with the work and who aided in many other ways.

BOOK REVIEW

Weeds of the Pacific Northwest. By Helen M. Gilkey. 441 pages. Oregon State College Press. 1957. Cloth bound.

The Pacific Northwest, as defined in the Preface, includes the states of Oregon, Washington, Idaho, the western portion of Montana, plus the agricultural areas of British Columbia, and Alaska. The distribution of the "weed" species under discussion are expressed with reference to the Cascade Range which serves as a natural dividing line. Those species adapted to the dryfarming areas are designated as "east of the Cascade" and those adapted to the more moist sites as "west of the Cascade."

In the Introduction it is stated that this manual was intended for the layman and rightly so. Notwithstanding that scientific names are retained, technical terms and expressions are reduced to a minimum. A simplified glossary precedes the Index and was intended to keep the context of the keys brief.

Very good illustrations are provided for leaf shapes, types, margins, and arrangements, veination, flower forms, inflorescences, and fruits to supplement the simple keys for the 46 families included in this publication. This is probably as good an approach as any for the novice. To the botanist or to one with some taxonomic training this is disturbing.

Four keys are included in this manual. There is a key to the families and one each for the grasses, Cruciferae, and Compositae. It is worthy of note that these keys were constructed to cover only the families and slightly more than 200 species included in the manual. The illustrations and descriptions alone were intended to be sufficient for recognition of many of the weeds. Many of the illustrations are complete showing gross habit, root system, stem, leaf, flower, and fruit. Others are not as complete but scanty. Incidentally, many of the illustrations are excellent.

The illustrations are found on the even-numbered pages and word descriptions on the odd-numbered pages facing the illustrations. These descriptions are reasonably complete but are in small type. Other useful information including place of origin and distribution follow and are in slightly larger type. Rarely is the whole page taken for all this information. The reviewer suggests that vegetative and reproductive descriptions be in much larger type and that such pertinent terms as life cycle, stem, leaves, flowers, etc. be in boldface type.

Eleven color plates are included. Some illustrate the whole plants, others merely portions of the plant. Their artistry is not good for the most part and these illustrations, unfortunately, do not contribute much to the importance of this publication.

Of the slightly more than 200 species listed the reviewer noted that approximately

40 species representing some 18 families are not included in *Gray's Manual of Botany* (8th Edition). The majority of these are native to the Western United States. It is interesting to note that the majority of species listed are introductions from Europe.

The arrangement of the families in the manual follows sound taxonomic principles and this contributes materially to the value of the book.

The manual was intended to serve the area of the country suggested in the title, but the reviewer feels that its scope is much greater. Amateur botanists, botanists themselves, and weed specialists in other areas of the country will find it useful.

A final comment is that the author's professional position be listed on the title page. —RICHARD D. ILNICKI, Research Agronomist, Weed Control in Crops Section, USDA, Farm Crops Dept., New Jersey Agr. Expt. Station, New Brunswick, N. J.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 86, No. 3, pp. 206–215 MAY, 1959

INDEX TO AMERICAN BOTANICAL LITERATURE

COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITOR OF BRITTONIA

TAXONOMY, PHYLOGENY AND FLORISTICS

ALGAE

Blum, John L. & Wilce, Robert T. Description, distribution and ecology of three species of *Vaucheria* previously unknown from North America. Rhodora **60**: 283–288. Oct [11 Nov] 1958.

Hollenberg, G. J. Observations concerning the life cycle of *Spongomorpha coalita* (Ruprecht) Collins. Madroño **14**: 249–251. 17 Oct 1958.

Patrick, Ruth. Some nomenclatural problems and a new species and a new variety in the genus *Eunotia* (Bacillariophyceae). Not. Nat. **312**: 1–15. 28 Nov 1958.

Randhawa, M. S. Notes on some new algae from India [3 spp. nov. etc.]. Bot. Gaz. **120**: 25–31. Sep [14 Nov] 1958.

Schumacher, George J. An unusual algal habitat. Jour. Elisha Mitchell Soc. **74**: 141, 142. Nov 1958.

Smith, Richard C. Some additions to the fresh-water algal flora of North Carolina: algae occurring with *Sphagnum*. Jour. Elisha Mitchell Soc. **74**: 158–160. Nov 1958.

Whitford, L. A. Phytoplankton in North Carolina lakes and ponds. Jour. Elisha Mitchell Soc. **74**: 143–157. Nov 1958.

BRYOPHYTES

Anderson, Lewis E. & Bryan, Virginia S. Chromosome numbers in mosses of eastern North America. Jour. Elisha Mitchell Soc. **74**: 173–199. Nov 1958.

Arnell, Sigfrid. New species of *Asterella* [*dominicensis*] and *Riccia* [*cubensis, ekmanii*] from Sto. Domingo and Cuba. Bryologist **61**: 140–143. Jun [Jul] 1958.

Clark, Lois. *Frullania breuteliana*. Bryologist **61**: 146–149. Jun [Jul] 1958.

Clark, Lois. *Frullania dubia*. Bryologist **61**: 149–151. Jun [Jul] 1958.

Clark, Lois. *Frullania gymnotis* found in the United States. Bryologist **61**: 67. Mar [5 Apr] 1958.

Clark, Lois. *Frullania longicollis*. Bryologist **61**: 143–146. Jun [Jul] 1958.

Clark, Lois. Hepaticae collected by Svihla near Seward and Fairbanks, Alaska. Bryologist **61**: 152, 153. Jun [Jul] 1958.

Crum, Howard. *Anacamptodon* in North America. Bryologist **61**: 136–140. Jun [Jul] 1958.

Györffy, Istyán. Novitas bryologica. VII. Pleurocarpy in *Polytrichum commune* var. *uliginosum*. Bryologist **61**: 132–136. Jun [Jul] 1958.

Iwatsuki, Zennoske. Review of the genus *Homaliadelphus*. Bryologist **61**: 68–78. Mar [5 Apr] 1958.

Kucyniak, James. On *Drepanocladus badius* in continental North America. Bryologist **61**: 124–132. Jun [Jul] 1958.

Kucyniak, James. Une mousse inattendue pour le Québec: *Pterigoneurum ovatum*. Nat. Canad. **85**: 217–224. Oct 1958.

Martin, William. Survey of moss distribution in New Zealand. Bryologist **61**: 105–115. Jun [Jul] 1958.

Schuster, Rudolf M. Keys to the orders, families and genera of Hepaticae of America north of Mexico. Bryologist **61**: 1–66. Mar [5 Apr] 1958.

Schuster, Rudolf M. Notes on nearctic Hepaticae VI. Phytogeographic relationships of critical species in Minnesota and adjacent areas of the Great Lakes. Rhodora **60**: 209–234. Aug [30 Sep]. 243–256. Sep [2 Oct] 1958.

Steere, William Campbell. The discovery of *Oreas martiana* in arctic Alaska: a genus new to North America. Bryologist **61**: 119–124. Jun [Jul] 1958.

Steere, William Campbell. *Oligotrichum falcatum*, a new species from arctic Alaska. Bryologist **61**: 115–118. Jun [Jul] 1958.

Fungi

(See also under Morphology: **Holm**)

Cash, Edith K. Some new Discomycetes from California [15 spp. nov.]. Mycologia **50**: 642–656. Sep–Oct [Dec] 1958.

Culberson, William Louis. The chemical strains of the lichen *Parmelia cetrarioides* Del. in North America. Phyton Buenos Aires **11**: 85–92. Sep 1958.

Cummins, George B. & Ramachar, P. The genus *Physopella* (Uredinales) replaces *Angiopsora*. Mycologia **50**: 741–744. Sep–Oct [Dec] 1958.

Davidson, Ross W. Additional species [6 spp. nov. etc.] of Ophiostomataceae from Colorado. Mycologia **50**: 661–670. Sep–Oct [Dec] 1958.

Dix, W. L. On *Anaptychia leucomelaena* fo. *filiformis*. Bryologist **61**: 153. Jun [Jul] 1958.

Emerson, Ralph. Mycological organization. Mycologia **50**: 589–621. Sep–Oct [Dec] 1958.

Fidalgo, Maria Eneyda Pacheco Kaufmann. Note on *Lenzites cinnamomea* Fr. Mycologia **50**: 753–756. Sep–Oct [Dec] 1958.

Gilman, J. C. & Tiffany, L. H. Iowa Diaportheae. Proc. Iowa Acad. **65**: 128–130. 1958.

Hale, Mason E. Chemical components of type specimens in *Parmelia*—I. Brittonia **10**: 177–180. 15 Oct 1958.

Hale, Mason E. Studies on the chemistry and distribution of North American lichens (10–13). Bryologist **61**: 81–85. Mar [5 Apr] 1958.

Heimsch, Charles. The first recorded truffle [*Tuber texense*] from Texas. Mycologia **50**: 657–660. Sep–Oct [Dec] 1958.

Howard, Grace E. Some lichens of western Alaska. Bryologist **61**: 85–92. Mar [5 Apr] 1958.

Martin, G. W. The contribution of de Bary to our knowledge of Myxomycetes. Proc. Iowa Acad. **65**: 122–127. 1958.

Martin, William. Notes on *Cladonia*, subgenus *Clathrina*. Bryologist **61**: 78–81. Mar [5 Apr] 1958.

Moore, Royall T. Deuteromycetes I: The *Sporidesmium* complex. Mycologia **50**: 681–692. Sep–Oct [Dec] 1958.

Peterson, John E. Two new fifty-year-old species of Myxobacteria. Mycologia **50**: 628–633. Sep–Oct [Dec] 1958.

Singer, Rolf. New genera of fungi, IX. The probable ancestor of the Strophariaceae: *Weraroa* gen. nov. Lloydia **21**: 45–47. Mar [Nov] 1958.

Singer, Rolf & Smith, Alexander H. Studies on secotiaceous fungi—I. A mono-

graph of the genus *Thaxterogaster*. Brittonia **10**: 201–216. *pl. 1, 2.* 15 Oct 1958. II. *Endoptychum depressum*. 216–221 *pl. 3.*

Singer, Rolf & Smith, Alexander H. Studies on secotiaceous fungi III. The genus *Weraroa*. Bull. Torrey Club **85**: 324–334. Sep–Oct [12 Nov] 1958.

Singer, R., Smith, A. H. & Huerta, G. Guzman. A new species of *Psathyrella*. Lloydia **21**: 26–28. Mar [Nov] 1958.

Snell, Walter H. & Dick, Esther A. Notes on the pileate hydnums. IV. Lloydia **21**: 34–37. Mar [Nov] 1958.

Sprague, Roderick & Rogerson, Clark T. Some leafspot fungi on Kansas Gramineae [6 spp. nov.] Mycologia **50**: 634–641. Sep–Oct [Dec] 1958.

Teixeira, Alcides Ribeiro. Studies on microstructure of *Laricifomes officinalis*. Mycologia **50**: 671–676. Sep–Oct [Dec] 1958.

Von Arx, J. A. Über einige Ascomyceten aus Südamerika. Acta Bot. Neerl. **7**: 503–518. Oct 1958.

Welden, Arthur L. A contribution toward a monograph of *Cotylidia* (Thelephoraceae). Lloydia **21**: 38–44. Mar [Nov] 1958.

Wolf, Frederick A. The conidial stage of *Lamprospora trachycarpa* (Curry) Seaver. Jour. Elisha Mitchell Soc. **79**: 163–166. Nov 1958.

Wolf, Frederick A. Spore discharge in *Taphrina*. Jour. Elisha Mitchell Soc. **79**: 161, 162. Nov 1958.

Ziegler, A. W. The Saprolegniaceae of Florida. Mycologia **50**: 693–696. Sep–Oct [Dec] 1958.

SPERMATOPHYTES

(See also under Morphology: **Pratt, Einset & Clausen**)

Bean, R. C., Hill, A. F. & Eaton, R. J. Twelfth report of the Committee on Plant Distribution. Rhodora **60**: 297–305. Nov [Dec] 1958.

Blake, S. F. Two species of *Hibiscus* from Texas. Jour. Wash. Acad. **48**: 277–280. Sep 1958.

Brade, A. C. Melastomatáceas novas do Estado do Rio Grande do Sul (Melastomataceae novae VI.). Sellowia **8**: 367–382. *pl. 1–12.* 31 Dec 1958.

Brizicky, George K., Stern, William L. & Chambers, Kenton L. A collection of woody plants from Panama. Trop. Woods **109**: 61–80. Oct 1958.

Brooks, Karl L. Some additions to the flora of Rockland County, New York. Bull. Torrey Club **85**: 378. Sep–Oct [12 Nov] 1958.

Carlquist, Sherwin. The woods and flora of the Florida Keys. Compositae. Trop. Woods **109**: 1–37. Oct 1958.

Cooperrider, Tom S. A preliminary report on the flora of Clinton, Jackson, and Jones Counties, Iowa. Proc. Iowa Acad. **65**: 110–112. 1958.

Dempster, Lauramay T. New names and combinations in the genus *Galium*. Brittonia **10**: 181–192. 15 Oct 1958.

Dnyansagar, V. R. Embryological studies in the Leguminosae. VIII. *Acacia auriculaeformis* A. Cunn., *Adenanthera pavonina* Linn., *Calliandra haematocephala* Hassk., and *Calliandra grandiflora* Benth. Lloydia **21**: 1–25. Mar [Nov] 1958.

Dugand, Armando. Noticias botánicas colombianas. XIII. Caldasia **8**[37]: 121–126. 30 Aug 1958.

Duman, Maximilian G. & Kryszczuk, *Sister* Dolores. Introgressive hybridization in the *Carex stans-bigelowii* complex. Bull. Torrey Club **85**: 359–362. Sep–Oct [12 Nov] 1958.

Fosberg, F. R. A new *Trichosanthes* (Cucurbitaceae) from Palau. Occ. Pap. Bishop Mus. **22**: 67–69. 29 Oct 1958.

Garay, Leslie A. Studies in American orchids IV. Bot. Mus. Leafl. **18**: 186–218. *pl. 34–43.* 20 Nov 1958.

Garber, E. D. The genus *Collinsia.* VII. Additional chromosome numbers and chiasmata frequencies. Bot. Gaz. **120**: 55, 56. Sep [14 Nov] 1958.

García-Barriga, Hernando & Hernández Camacho, Jorge. Dos especies nuevas de *Carica.* Caldasia 8^{37}: 135–142. 30 Aug 1958.

Gleason, H. A. Melastomataceae. *In:* Woodson et al., Flora of Panama. Part VII, Fascicle 3. Ann. Missouri Bot. Gard. **45**: 203–304. Sep [28 Oct] 1958.

Godfrey, R. K. & Kral, Robert. Observations on the Florida flora. Brittonia **10**: 166–177. 15 Oct 1958.

Heiser, Charles B. Three new annual sunflowers (*Helianthus*) from the southwestern United States. Rhodora **60**: 272–283. Oct [11 Nov] 1958.

Hermann, F. J. *Euphrasia micrantha* new to North America. Rhodora **60**: 307, 308. Nov [15 Dec] 1958.

Hoehne, F. C. Concerning the genus *Laelia* Lindl. of the Orchidaceae and its new species from the state of Minas Gerais. Am. Orchid Soc. Bull. **27**: 400–402. Jun 1958.

Horton, James H. Notes on the flora of Rowan County, North Carolina. Jour. Elisha Mitchell Soc. **79**: 200–205. Nov 1958.

Howard, Richard A. La vegetación de las islas Beata y Alta Vela de la Hispaniola. Anal. Univ. S. Domingo **22**(81–84): 305–355. 1957.

Kelso, Leon. Monticolae: historia naturalis. Biol. Leafl. **67**: 1–4. 14 Nov 1958.

Laird, Lloyd W. & Ignoffo, Carlo M. The progression of spring in southwestern Iowa. Proc. Iowa Acad. **65**: 113–117. 1958.

Legrand, C. Diego. Myrtaceae catharinenses novae. Sellowia **8**: 71–79. *pl. 1–6.* 31 Dec 1957.

McVaugh, Rogers. [Myrtaceae in] Flora of Peru. Field Mus. Publ. Bot. **13**(4^{2}): 579–818. 28 Nov 1958.

Maguire, Bassett & Wurdack, John J. New Guayana Compositae. Bol. Soc. Venez. Ci. Nat. 20^{91}: 54–59. Oct 1958.

Mattos, João Rodrigues. Notas preliminares sôbre as mirtáceas de São Joaquim (S. Catarina). Sellowia **8**: 354–366. 31 Dec 1957.

Mohlenbrock, Robert H. Field and herbarium studies in southern Illinois. Rhodora **60**: 292–297. Nov [15 Dec] 1958.

Mohlenbrock, Robert H. The *Stylosanthes biflora* complex. Bull. Torrey Club **85**: 341–346. Sep–Oct [12 Nov], 1958.

Morley, Thomas. Note on the distinction between the broad- and narrow-leaved antennarias of Minnesota. Rhodora **60**: 306. Nov [5 Dec] 1958.

Pabst, G. F. J. Contribuição ao conhecimento das orquídeas de Santa Catarina e sua dispersão geográfica—IV. Sellowia **8**: 249–258. *pl. 1.* 31 Dec 1957.

Pittendrich, Colin S. A new bromeliad from the northern range in Trinidad. Jour. Wash. Acad. **48**: 315, 316. Oct 1958.

Pittier, Henri. Ensayo sobre plantae usuales de Costa Rica. Segunda edición revisada. Publ. Univ. Costa Rica Ser. Ci. Nat. **2**: 1–264. *25 pl.* 1957.

Rambo, B. O gênero *Eryngium* no Rio Grande do Sul. Sellowia **8**: 299–353. 31 Dec 1957.

Reitz, P. Raulino. Aráceas catarinenses. Sellowia **8**: 20–70. *pl. 1–8.* 31 Dec 1957.

Romero Castañeda, Rafael. Una nueva especie de *Aragoa* [*dugandii*]. Caldasia 8^{37}: 131–133. 30 Aug 1958.

Russell, Norman H. The nature of *Viola missouriensis* Greene. Proc. Iowa Acad. **65**: 96–101. 1958.

Russell, Norman H. & Graham, Jeanette. Midwestern population studies of *Viola papilionacea* Pursh. Proc. Iowa Acad. **65**: 102–109. 1958.

St. John, Harold. Nomenclature of plants. A text for the application by the case method of the *International Code of Botanical Nomenclature*. i–v, 1–157. Ronald Press. New York, 1958.

Schapaugh, William. *Salsola collina* Pall., new to Iowa. Proc. Iowa Acad. **65**: 118–121. 1958.

Schneider, Martin. Algunas especies colombianas de *Pleurothallis*. Caldasia **8**[37]: 99–120. 30 Aug 1958.

Schultes, Richard Evans. A little-known cultivated plant from northern South America. Bot. Mus. Leafl. **18**: 229–244. *pl. 46–49*. 20 Nov 1958.

Schweinfurth, Charles. Two additions to the orchid flora of Venezuela. Bot. Mus. Leafl. **18**: 219–228. *pl. 44, 45*. 20 Nov 1958.

Sealy, J. Robert. *Camassia cusickii*. Liliaceae [NE Oregon]. Bot. Mag. **172**: *pl. 319*. Oct 1958.

Small, John A. & Martin, William A. A partially annotated catalogue of vascular plants reported from Island Beach State Park, New Jersey. Bull. Torrey Club **85**: 368–377. Sep–Oct [12 Nov] 1958.

Smith, Dale M. A new species of *Helianthus* [*glaucophyllus*] from North Carolina and Tennessee. Brittonia **10**: 192–194. 15 Oct 1958.

Smith, Lyman B. Notes on South American phanerogams—I. Jour. Wash. Acad. **48**: 282–284. Sep. II. 310–314. Oct 1958.

Smith, Lyman B. Tres bromeliáceas novas do Museu Paraense Emilio Goeldi. Bol. Mus. Emilio Goeldi II. Bot. **1**: 1–4. *1 pl.* Mar 1958.

Smith, Lyman B. & Downs, Robert J. Resumo preliminar das mirsináceas de Santa Catarina. Sellowia **8**: 237–248. *pl. 1–4*. 31 Dec 1957.

Stern, William L. & Brizicky, George K. The woods and flora of the Florida Keys. Goodeniaceae. Trop. Woods **109**: 38–44. Oct 1958.

Stern, William L. & Brizicky, George K. The woods and flora of the Florida Keys. Passifloraceae. Trop. Woods **109**: 45–53. Oct 1958.

Strausbaugh, P. D. & Core, Earl L. Flora of West Virginia (part III). W. Va. Univ. Bull. Ser. 58 no. 12–3: 571–860. Jun 1958.

Terrell, Edward E. *Striga asiatica* and *Chrysoma pauciflosculosa* in the Carolinas. Rhodora **60**: 289–291. Nov [15 Dec] 1958.

Turrill, W. B. *Penstemon bradburii*. Scrophulariaceae [Central U. S. A.]. Bot. Mag. **172**: *pl. 326*. Oct 1958.

Uribe Uribe, Lorenzo. Sertula florae Colombiae, IV. Caldasia **8**[37]: 127–130. 30 Aug 1958.

Vélez, Ismael. Herbaceous angiosperms of the Lesser Antilles. Univ. Puerto Rico Biol. Dep. 1–121. 1957.

Weber, William A. Rediscovery of the genus *Neoparrya* Mathias (Umbelliferae). Rhodora **60**: 265–271. Oct [11 Nov] 1958.

Wiggins, Ira L. & MacVicar, Donald G. Notes on the plants in the vicinity of Chandler Lake, Alaska. Contr. Dudley Herb. **5**: 69–95. 1 Nov 1958.

Woodson, Robert E., Schery, Robert W. *et al.* Flora of Panama. Part VII, Fascicle 3 (Melastomataceae). Ann. Missouri Bot. Gard. **45**: 203–304. Sep [28 Oct] 1958.

PALEOBOTANY

Andrews, Henry N. & Mamay, Sergius H. A brief conspectus of American coal ball studies. Paleobotanist **1**: 66–72. *pl. 1–5*. 1952.

Arnold, Chester A. Tertiary plants from North America. Paleobotanist **1**: 73–78. *pl. 1*. 1952.

Berry, E. Willard. The pleistocene plant remains of the coastal plains of eastern North America. Paleobotanist **1**: 79–98. 1952.

Chaney, Ralph W. Conifer dominants in the middle Tertiary of the John Day Basin, Oregon. Paleobotanist **1**: 105–113. 1952.

Darrah, William Culp. The materials and methods of paleobotany. Paleobotanist **1**: 145–153. *pl. 1.* 1952.

Davis, Margaret Bryan. Three pollen diagrams from central Massachusetts. Am. Jour. Sci. **256**: 540–570. *pl. 2–4* ["pl. 1" = p. 545]. Oct 1958.

Hoskins, J. H. & Cross, A. T. The petrification flora of the Devonian-Mississippian black shale. Paleobotanist **1**: 215–238. 1952.

Howell, B. F. Calcareous algae as index fossils. Paleobotanist **1**: 239, 240. 1952.

ECOLOGY AND PLANT GEOGRAPHY

Conard, Henry S. A fen in southwestern Missouri. Proc. Iowa Acad. **65**: 206, 207. 1958.

Crandall, Dorothy L. Ground vegetation patterns of the spruce-fir area of the Smoky Mountains National Park. Ecol. Monogr. **28**: 339–360. Oct 1958.

Fritts, Harold C. An analysis of radial growth of beech in a central Ohio forest during 1954–55. Ecology **39**: 705–720. Oct 1958.

Humphrey, R. R. & Mehrhoff, L. A. Vegetation changes on a southern Arizona grassland range. Ecology **39**: 720–726. Oct 1958.

Laessle, Albert M. The origin and successional relationship of sandhill vegetation and sand-pine scrub. Ecol. Monogr. **28**: 337–360. Oct 1958.

Mark, A. F. The ecology of the southern Appalachian grass balds. Ecol. Monogr. **28**: 293–336. Oct 1958.

Neiland, Bonita J. Forest and adjacent burn in the Tillamook burn area of northwestern Oregon. Ecology **39**: 660–671. Oct 1958.

Rambo, B. Regenwald und Kamp in Rio do Sul. Sellowia **8**: 257–298. 31 Dec 1957.

Ramia, Mauricio. Los médanos del Guárico Occidental. Bol. Soc. Venez. Ci. Nat. **20**^{91}: 41–53. Oct 1958.

Tevis, Lloyd. Germination and growth of ephemerals induced by sprinkling a sandy desert. Ecology **39**: 681–695. Oct. 1958.

Veloso, Henrique P. & Klein, Roberto M. As communidades e associaçoes vegetais da mata pluvial do sul do Brasil—I. As communidades do Município do Brusque, Est. Santa Catarina. Sellowia **8**: 81–235. 31 Dec 1957 .

Voss, G. L. & Voss, N. A. An ecological survey of Soldier Key, Biscayne Bay, Florida. Bull. Marine Sci. Gulf Carib. **5**^{3}: 203–229. 1955.

Weaver, J. E. Native grassland of southwestern Iowa. Ecology **39**: 733–750. Oct 1958.

Whitford, Philip B. A study of prairie remnants in southeastern Wisconsin. Ecology **39**: 727–733. Oct 1958.

MORPHOLOGY
(including anatomy and cytology in part)
(See also under Spermatophytes: **Cariquist**)

Bell, P. R. Induced apospory in polypodiaceous ferns. Nature **182**: 1848, 1749. 20 Dec 1958.

Benjamin, R. K. On the relation of the sexual and nonsexual phases of *Gonapodya*. Mycologia **50**: 789–792. Sep–Oct [Dec] 1958.

Bierhorst, David W. Systematic changes in the shoot apex of *Psilotum*. Bull. Torrey Club **85**: 231–241. Jul–Aug [16 Oct] 1958.

Briggs, W. R. & Steeves, T. A. Morphogenetic studies on *Osmunda cinnamomea* L.—The expansion and maturation of vegetative fronds. Phytomorphology **8**: 234–248. Jul [Oct] 1958.

Butler, Gillian M. The development and behaviour of mycelial strands in *Merulius lacrymans* (Wulf) Fr. II. Hyphal behaviour during strand formation. Ann. Bot. II. **22**: 219–236. Apr [Mai] 1958.

Carlquist, Sherwin. Structure and ontogeny of glandular trichomes of Mad[i]inae (Compositae). Am. Jour. Bot. **45**: 675–682. 22 Nov 1958.

Drechsler, Charles. Formation of sporangia from conidia and hyphal segments in an Indonesian *Basidiobolus*. Am. Jour. Bot. **45**: 632–638. Oct [19 Nov] 1958.

Ehrlich, Howard G. Nuclear behavior in mycelium of a solopathogenic line and in a cross of two haploid lines of *Ustilago maydis* (DC.) Cda. Mycologia **50**: 622–627. Sep–Oct [Dec] 1958.

Fahn, Abraham. Xylem structure and annual rhythm of development in trees and shrubs of the desert. 1. *Tamarix aphylla, T. jordanis* var. *negevensis, T. gallico* var. *marismortui*. Trop. Woods **109**: 81–94. Oct 1958.

Hackett, David P. Some observations on the submicroscopic structure of cytoplasmic particles isolated from a higher plant [*Symplocarpus foetidus*]. Cytologia **23**: 86–91. 25 Mar 1958.

Hassan, Ikran & Dunn, M. S. Studies of the genus *Thymus*. Part I. Comparison of the diagnostic microscopical characteristics of *Thymus vulgaris* Linn. and *Thymus Serpyllum* Linn. Am. Jour. Pharm. **129**: 362–371. Oct 1957.

Hollenberg, George J. Culture studies of marine algae. III. *Porphyra perforata*. Am. Jour. Bot. **45**: 653–656. 22 Nov 1958.

Holm, Lennart. Some comments on the ascocarps of the Pyrenomycetes. Mycologia **50**: 777–788. Sep–Oct [Dec] 1958.

Johnson, Marion A. The epiphyllous flowers of *Turnera* and *Helwingia*. Bull. Torrey Club **85**: 313–323. Sep–Oct [12 Nov] 1958.

Lingappa, B. T. The cytology of development and germination of resting spores of *Synchytrium brownii*. Am. Jour. Bot. **45**: 613–620. Oct [19 Nov] 1958.

Lingappa, B. T. Sexuality in *Synchytrium brownii* Karling. Mycologia **50**: 524–537. Jul–Aug [6 Oct] 1958.

Lowy, B. Anomalous phalloids. Mycologia **50**: 792–794. Sep–Oct [Dec] 1958.

Mosely, M. F. Morphological studies of the Nymphaeaceae—I. The nature of the stamens. Phytomorphology **8**: 1–29. Jul [Oct] 1958.

Partanen, Carl R. Application of autoradiographic techniques to studies of shoot apices. Nature **182**: 1747, 1748. 20 Dec 1958.

Patman, Jacqueline. Morphologic variation in the genus *Brassica*. Proc. Iowa Acad. **65**: 86–95. 1958.

Post, Douglas M. Studies in Gentianaceae, I. Nodal anatomy of *Frasera* and *Swertia perennis*. Bot. Gaz. **120**: 1–14. Sep [14 Nov] 1958.

Pratt, Charlotte, Einset, John & Clausen, Robert T. Embryology, breeding behavior and morphological characteristics of apomictic, triploid *Rubus idaeus* L. Bull. Torrey Club **85**: 242–254. Jul–Aug [16 Oct] 1958.

Stall, R. E. An investigation of nuclear number in *Alternaria solani*. Am. Jour. Bot. **45**: 657–659. 22 Nov 1958.

Steeves, T. A. & Briggs, W. R. Morphogenetic studies on *Osmunda cinnamomea* L.—The origin and early development of vegetative fronds. Phytomorphology **8**: 60–72. Jul [Oct] 1958.

Stein, Janet R. A morphologic and genetic study of *Gonium pectorale*. Am. Jour. Bot. **45**: 664–672. 22 Nov 1958.

Sterling, Clarence. Dormant apical bud of *Agathis lanceolata*. Bot. Gaz. **120**: 49–53. Sep [14 Nov] 1958.

Sterling, Clarence & Spit, B. J. Submicroscopic structure of the cereal starch grain. Jour. Exp. Bot. 9^{25}: 75–81. Feb 1958.

Webster, Barbara & Steeves, T. A. Morphogenesis in *Pteridium aquilinum* (L.) Kuhn.—General morphology and growth habit. Phytomorphology **8**: 30–41. Jul [Oct] 1958.

Weier, T. Elliot. The cytology of mesophyll tissue in *Oenothera* and *Nicotiana*. Am. Jour. Bot. **45**: 603–608. Oct [19 Nov] 1958.

GENETICS
(including cytogenetics)

(See also under Morphology: **Ehrlich; Stein;** under Phytopathology: **Athow & Davis; Johnson & Hagedorn; Schroeder & Barton**)

Aalders, Lewis E. Monoploidy in cucumbers. Jour. Hered. **49**: 40–44. Jan–Feb [Apr] 1958.

Bell, William D., Bogorad, Lawrence & McIlrath, Wayne J. Response of the yellow-stripe maize mutant (ys_1) to ferrous and ferric iron. Bot. Gaz. **120**: 36–39. Sep [14 Nov] 1958.

Cohn, Norman S. An analysis of the rejoining of X-ray-induced broken ends of chromosomes in the root tips of *Allium cepa*. Genetics **43**: 362–373. Mai [Oct] 1958.

Davis, Elmo W. Male-sterility in onion plants from Turkey. Jour. Hered. **49**: 31, 32. Jan–Feb [Apr] 1958.

Foley, Jean M. The occurrence, characteristics and genetic behavior of albino gametophytes in *Allomyces*. Am. Jour. Bot. **45**: 639–648. Oct [19 Nov] 1958.

Hougas, R. W., Peloquin, S. J. & Ross, R. W. Haploids of the common potato. Jour. Hered. **49**: 103–106. Mai–Jun [Aug] 1958.

House, L. R. & Nelson, O. E. Tracer study of pollen-tube growth in cross-sterile maize. Jour. Hered. **49**: 18–21. Jan–Feb [Apr] 1958.

James, Allen P. & Spencer, Peter E. The process of spontaneous extranuclear mutation in yeast. Genetics **43**: 317–331. Mai [Oct] 1958.

Koo, F. K. S. Pseudo-isochromosomes produced in *Avena strigosa* Schreb. by ionizing radiations. Cytologia **23**: 109–111. 25 Mar 1958.

Lebedeff, G. A. Inheritance of loose pericarp in corn. Jour. Hered. **49**: 128–132. Mai–Jun [Aug] 1958.

Lesley, J. W., Lesley, Margaret M. & Turrell, F. M. Cytogenetic and pigment studies of a blue-green mutant from P^{32} treated seeds of the tomato. Am. Jour. Bot. **45**: 599–602. Oct [19 Nov] 1958.

Markarian, D. & Schulz-Schaeffer, J. A possible origin of supernumerary fragment chromosomes. Jour. Hered. **49**: 2–7. Jan–Feb [Apr] 1958.

Moseman, J. G. & Starling, T. M. Genetics of resistance of the barley varieties Ricardo and Modia to several cultures of *Erysiphe graminis* f. sp. *hordei*. Phytopathology **48**: 601–604. Nov 1958.

Oka, Hiko-Ichi, Hayashi, Jiro & Shiojiri, Isamu. Induced mutations of polygenes for quantitative characters in rice. Jour. Hered. **49**: 11–14. Jan–Feb [Apr] 1958.

Pateman, J. A. Back-mutation studies at the *AM* locus in *Neurospora crassa*. Jour. Genet. **55**: 444–466. Dec 1957.

Peterson, Peter A. The effect of temperature on the mutation rate of a mutable locus in maize. Jour. Hered. **49**: 120–124. Mai–Jun [Aug] 1958.

Raper, John R. & Krongelb, Gladys S. Genetic and environmental aspects of fruiting in *Schizophyllum commune* Fr. Mycologia **50**: 707–740. Sep–Oct [Dec] 1958.

Riley, Ralph, Unrau, John & Chapman, Victor. Evidence on the origin of the B genome of wheat. Jour. Hered. **49**: 90–98. Mai–Jun [Aug] 1958.

Sarvella, Patricia. Cytomixis and the loss of chromosomes in meiotic and somatic cells of *Gossypium*. Cytologia **23**: 14–24. 25 Mar 1958.

Sharma, Arun Kumar & Sharma, Archana. Recent advances in the study of chromosome structure. Bot. Rev. **24**: 511–549. Oct 1958.

Storey, H. H. & Howland, Audrie K. Resistance in maize to the tropical American rust fungus, *Puccinia polysora* Underw. I. Genes Rpp_1 and Rpp_2. Heredity **11**: 289–301. *1 pl.* Dec 1957 [1958].

Stanford, E. H. & Clement, W. M. Cytology and crossing behavior of a haploid alfalfa plant. Agron. Jour. **50**: 589–592. Oct 1958.

Tinline, R. D. & Dickson, J. G. *Cochliobolus sativus*. I. Perithecial development and the inheritance of spore color and mating type. Mycologia **50**: 697–706. Sep–Oct [Dec] 1958.

PHYTOPATHOLOGY

Athow, Kirk L. & Davis, Ralph L. Inheritance of resistance to southern anthracnose in red clover. Phytopathology **48**: 437, 438. Aug [15 Sep] 1958.

Blodgett, Earle C. & Twomey, James A. Virus gummosis of apricot. Phytopathology **48**: 435–437. Aug [15 Sep] 1958.

Brakke, Myron K. Properties, assay, and purification of wheat streak mosaic virus. Phytopathology **48**: 439–445. Aug [15 Sep] 1958.

Changari, Winit & Weber, George F. Leafspot of marigold, *Tagetes erecta*, caused by *Septoria tageticola* n. sp. Phytopathology **48**: 561–565. Oct [26 Nov] 1958.

Chapman, Richard A. The effect of root-lesion nematodes on the growth of red clover and alfalfa under greenhouse conditions. Phytopathology **48**: 525–530. Oct [26 Nov] 1958.

Childs, J. F. L., Norman, G. G. & Eichhorn, J. L. A color test for exocortis infection in *Poncirus trifoliata*. Phytopathology **48**: 426–432. Aug [15 Sep] 1958.

Chinn, S. H. F. & Russell, R. C. The control of soaking injury of barley seed. Phytopathology **48**: 553–556. Oct [26 Nov] 1958.

Daines, Robert H. *et al.* Control of *Fusicoccum* canker of peach by nutrition, defoliation, and protective fungicides. Phytopathology **48**: 400–407. Aug [15 Sep] 1958.

Dewey, Wade & Tyler, L. J. Germination studies with spores of the dwarf bunt fungus. Phytopathology **48**: 579, 580. Oct [26 Nov] 1958.

Dunleavy, John. Studies of a seedling blight of soybeans and the etiology of the causal fungus, *Diaporthe phascolorum* var. *caulivora*. Proc. Iowa Acad. **65**: 131–145. 1958.

Endo, B. Y. & Sasser, J. N. Soil fumigation experiments for the control of the soybean cyst nematode, *Heterodera glycines*. Phytopathology **48**: 571–574. Oct [26 Nov] 1958.

Garber, E. D. & Heggestad, Howard E. Observations on the pathogenicity of biochemical mutants of *Pseudomonas tabaci*. Phytopathology **48**: 535–537. Oct [26 Nov] 1958.

Gilmer, R. M. Two viruses that induce mosaic of apple. Phytopathology **48**: 432–437. Aug [15 Sep] 1958.

Good, J. M., Boyle, L. W. & Hammons, R. O. Studies of *Pratylenchus brachyurus* on peanuts. Phytopathology **48**: 530–535. Oct [26 Nov] 1958.

Green, Ralph J. "Deep plowing" for controlling *Verticillium* wilt of mint in muck soils. Phytopathology **48**: 575–577. Oct [26 Nov] 1958.

Haunold, Ernst. Factors affecting the virus content of Cheyenne wheat infected by wheat streak mosaic. Phytopathology **48**: 411–414. Aug [15 Sep] 1958.

Hewitt, Wm. B., Raski, D. J. & Goheen, A. C. Nematode vector of soil-borne fanleaf virus of grapevines. Phytopathology **48**: 586–595. Nov [Dec] 1958.

Jackson, L. W. R. & Parker, J. Neil. Anatomy of fusiform rust galls on loblolly pine. Phytopathology **48**: 637–640. Nov [Dec] 1958.

Johnson, K. W. & Hagedorn, D. J. The inheritance of resistance to bean virus 2 in *Pisum sativum*. Phytopathology **48**: 451–453. Aug [15 Sep] 1958.

Joshi, N. C. & Agnihotri, J. P. Studies on the wilt disease of cumin (*Cuminum Cyminum* L.) in Ajmir State, India. Lloydia **21**: 29–33. Mar [Nov] 1958.

Klotz, L. J., DeWolfe, T. A. & Wong, Po-Ping. Decay of fibrous roots of citrus. Phytopathology **48**: 616–622. Nov [Dec] 1958.

McClellan, W. D., Taylor, Edgar A. & Smith, Floyd F. Winter treatments of dormant roses and their relation to blackspot and spider mite control. Phytopathology **48**: 408–410. Aug [15 Sep] 1958.

Martin, W. J. Reaction of sweet potato varieties and seedlings to soil rot. Phytopathology **48**: 445–448. Aug [15 Sep] 1958.

Miller, P. M. & Wagonner, P. E. Dissemination of *Venturia inaequalis* ascospores. Phytopathology **48**: 416–419. Aug [15 Sep] 1958.

Munnecke, Donald E. The persistence of nonvolatile diffusible fungicides in soil. Phytopathology **48**: 581–585. Nov [Dec] 1958.

Nelson, Paul E. & Wilhelm, Stephen. Thermal death range of *Verticillium albo-atrum*. Phytopathology **48**: 613–616. Nov [Dec] 1958.

Olson, Edward O. Responses of lime and sour orange seedlings and four scion-rootstock combinations to infection by strains of the tristeza virus. Phytopathology **48**: 454–459. Aug [15 Sep] 1958.

Panzer, J. D. The effect of pre-inoculation temperature on test plant susceptibility to alfalfa and tobacco mosaic virus. Phytopathology **48**: 550–552. Oct [26 Nov] 1958.

Pederson, Vernyl D. A new method of obtaining systemic infection of soybeans by *Peronospora manshurica* (Naoum.) Syd. Proc. Iowa Acad. **65**: 146–149. 1958.

Perry, Vernon G. Parasitism of two species of dagger nematodes (*Xiphinema americanum* and *X. chambersi*) to strawberry. Phytopathology **48**: 420–423. Aug [15 Sep] 1958.

Probst, A. H. & Athow, Kirk L. Additional studies on the inheritance of resistance to frog-eye leaf spot of soybeans. Phytopathology **48**: 414–416. Aug [15 Sep] 1958.

Purdy, Lawrence H. Some factors affecting penetration and infection by *Sclerotinia sclerotiorum*. Phytopathology **48**: 605–609. Nov [Dec] 1958.

Qasem, Subhi A. & Christensen, Clyde M. Influence of moisture content, temperature, and time on the deterioration of stored corn by fungi. Phytopathology **48**: 544–549. Oct [26 Nov] 1958.

Raabe, Robert D. & Wilhelm, Stephen. *Verticillium* wilt of garden stock (*Matthiola incana*). Phytopathology **48**: 610–613. Nov [Dec] 1958.

Rich, Saul. Fertilizers influence the incidence of tomato internal browning in the field. Phytopathology **48**: 448–450. Aug [15 Sep] 1958.

Ross, J. P. Host-parasite relationship of the soybean cyst nematode in resistant soybean roots. Phytopathology **48**: 578, 579. Oct [26 Nov] 1958.

Schnathorst, W. C., Grogan, R. G. & Bardin, Roy. Distribution, host range, and origin of lettuce powdery mildew. Phytopathology **48**: 538–543. Oct [26 Nov] 1958.

Schroeder, W. T. & Barton, D. W. The nature and inheritance of resistance to the pea enation mosaic virus in garden pea, *Pisum sativum* L. Phytopathology **48**: 628–632. Nov [Dec] 1958.

Shigo, Alex L. Fungi isolated from oak-wilt trees and their effects on *Ceratocystis fagacearum*. Mycologia **50**: 757–769. Sep–Oct [Dec] 1958.

Struckmeyer, B. Esther, Kuntz, J. E. & Riker, A. J. Histology of certain oaks infected with the oak wilt fungus. Phytopathology **48**: 556–561. Oct [26 Nov] 1958.

Tammen, James. Pathogenicity of *Fusarium roseum* to carnation and to wheat. Phytopathology **48**: 423–426. Aug [15 Sep] 1958.

Todd, E. H. & Atkins, John G. White tip disease of rice. I. Symptoms, laboratory culture of nematodes, and pathogenicity tests. Phytopathology **48**: 632–637. Nov [Dec] 1958.

Tyler, L. J. & Jensen, N. F. Some factors that influence development of dwarf bunt in winter wheat. Phytopathology **48**: 565–571. Oct [26 Nov] 1958.

Wilson, Eugene M. & Ark, Peter A. Acti-dione as a control of seed-borne safflower rust. Phytopathology **48**: 460. Nov [Dec] 1958.

GENERAL BOTANY
(including biography and nomenclature)

Brandes, E. W., Coons, G. H. & Eames, A. J. Ernst Artschwager, plant anatomist and morphologist. Phytomorphology **8**: 249–252. Jun 1958.

[Howell, John Thomas.] Thomas Henry Kearney: autobiographical notes. Leafl. West. Bot. **8**: 273–275. 24 Nov 1958.

Garay, Leslie A. & Schultes, Richard Evans. How absurd can a nomenclatural proposal be? Bot. Mus. Leafl. **18**: 181–185. 20 Nov 1958.

Kearney, Thomas H. Botanists I have known. Leafl. West. Bot. **8**: 275–280. 24 Nov 1958.

Lanjouw, J. Thomas Archibald Sprague. Taxon **8**: 1. 5 Jan 1959.

McClintock, Elizabeth. Bibliography of the scientific writings of Thomas H. Kearney. Leafl. West. Bot. **8**: 280–287. 24 Nov 1958.

Matzke, Edwin B. Sam Farlow Trelease. Bull. Torrey Club **85**: 379–382. Sep [Nov] 1958.

Mayr, Ernst. The evolutionary significance of the systematic categories. Uppsala Univ. Årsskr. **1958**^{6}: 13–20. 1958.

Morton, C. V. The new edition of the *International code of botanical nomenclature*. AIBS Bull. **8**^{5}: 24–26. Nov 1958.

Proskauer, J. On law, order and family. Taxon **7**: 213–218. Oct 1958.

Reitz, P. Raulino. Through the world herbaria. Sellowia **8**: 9–19. 31 Dec 1957.

Robbins, William J. Elmer Drew Merrill, Oct. 15, 1876–February 25, 1956. Biogr. Mem. Natl. Acad. **32**: 273–333. *port.* 1958.

Silva, Paul C. A logical approach to the Code. Taxon **8**: 3–11. 5 Jan 1959.

Stakman, E. C. The role of plant pathology in the scientific and social development of the world. AIBS Bull. **8**^{5}: 15–18. Nov 1958.

Stebbins, C. Ledyard. Ernest Brown Babcock, July 10, 1877—December 8, 1954. Biogr. Mem. Natl. Acad. **32**: 50–66. *port.* 1958.

Valentine, D. H. & Löve, Áskell. Taxonomic and biosystematic categories. Brittonia **10**: 153–166. 15 Oct 1958.

Van der Hammen, T. Recommendations and proposals for palynological systematic nomenclature. Taxon **7**: 273, 274. Nov–Dec 1958.

Walker, J. C. Benjamin Minge Duggar. September 1, 1872–September 10, 1956. Biogr. Mem. Natl. Acad. **32**: 113–131. *port.* 1958.

MAXIMUM STORAGE

Lane Herbarium Case
The Accepted Standard for general use

Lane HERBARIUM CASES

NOW IN USE IN OVER 115 UNIVERSITIES, BOTANICAL GARDENS, NATIONAL PARKS, ETC. since their introduction!

SPECIFICATIONS

STANDARD HERBARIUM
84 1/8" High, 27-13/16" Wide, 18-25/32" Deep

JUNIOR MODEL HERBARIUM
40" High, 27-13/16" Wide, 18-25/32" Deep

SOME USERS OF LANE HERBARIUM CASES

New York Botanical Gardens
Abilene Christian College
Agricultural & Mechanical College of Texas
Duquesne University
Florida State University
Georgia Teachers College
Louisiana Polytechnic Institute
Loyola University
Oklahoma Agricultural & Mechanical College
Southern Methodist University
State College of Washington
Tulane University
University of Alabama
University of Arizona
University of Arkansas
University of Chattanooga
University of Massachusetts
University of Idaho
University of Nevada
University of Texas
University of Wisconsin
Washington University
Yale University
Grand Canyon National Park
Olympic National Park
Hawaii National Park
Glacier National Park
Canisius College
Catholic University of Washington
Carleton College
Emory University
U. S. Dept. of Agriculture
Oregon State College
Riverside Municipal Museum
Rutgers University